DEC 2 '12
PUBLIC SERVICE TECHNICAL LIBRARY
NEWARK, N. J.

PRACTICAL
ENGINEER
Trade-mark reg. U. S. Pat. Office.
VOL. XVI CHICAGO, DECEMBER 1, 1912 No. 23

POWER PLANT OF A MODERN HOSTELRY

Mechanical Equipment of the Onondaga Hotel, Syracuse, N. Y., Including Lighting, Heating and Power Apparatus, Together with a Complete Ice Making and Refrigerating Plant

"FRONT; SHOW THE GENTLEMAN to room 90," with these words the clerk handed the "bell hop" the key and the writer wearily followed him to the elevator and was shot up to the ninth floor.

It was one of those cool evenings in the early autumn and the gentle heat of the corridors was extremely agreeable after coming from the chilly atmosphere without. A flood of light from many incandescent lamps added to the general sense of comfort and made a fellow realize that way down several stories underground were located many machines for producing light, heat and power for the building. As the next day was Sunday, a visit to the power plant was decided upon.

Modern hotels represent about the best example of power plant practice, as the service requirements are widely diversified, including heating, lighting, ventilation, refrigeration and ice making. The Onondaga Hotel, Syracuse, N. Y., is no exception, and the plant represents the latest equipment and practice.

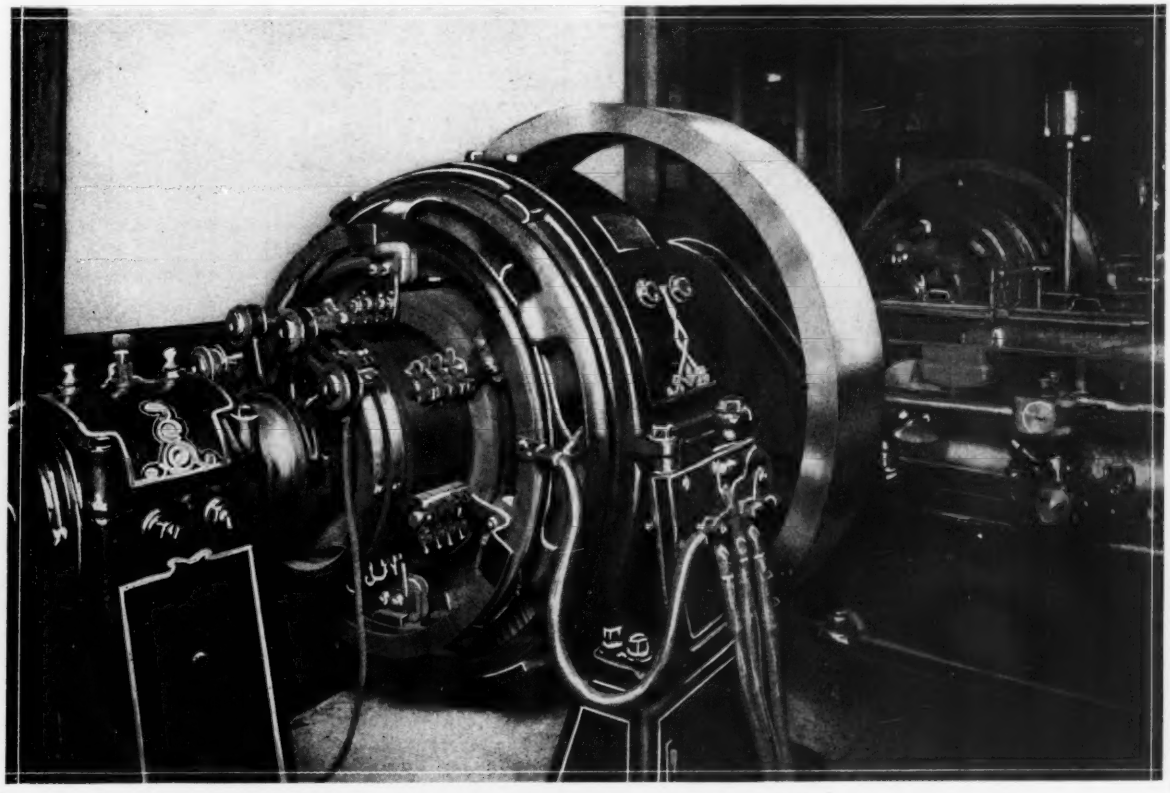


FIG. 1. CORNER OF ENGINE ROOM SHOWING 2 OF THE GENERATING UNITS

Boilers and Feed Water

IN the boiler room are 3 150-hp. return tubular horizontal boilers 72 in. by 18 ft., made by the Oil Well Supply Co., of Oswego, N. Y. Each boiler has 112 3-in. tubes, 6750 sq. ft. of heating surface and is equipped with grates 6 ft. 6 in. by 6. ft. 6 in. The auxiliary apparatus for each boiler includes a Crosby safety valve; Ashcroft steam gage; Lunkenheimer feed water valves and check valves; and a Reliance high and low alarm water column.

The steam outlets are 6 in. in diameter and the steam mains leading to the engines, 5 in.; to ammonia compressor, 2½ in. and 1¼ in. respectively.

A reinforced concrete stack 175 ft. in height with a 6-ft. flue supplies natural draft. The surface of boiler room floor is 23 ft. below the street level and adjacent to the boiler room are the coal bunkers having 110 tons capacity. The boilers are hand fired, the fuel used being anthracite buckwheat coal, which is delivered from the street to the bunkers.

City water, used for boiler and feed purposes, is heated by a Webster open heater, the water supply being controlled automatically so that a constant water level is maintained within the heater. Entering the heater through the inlet valve, the water passes into the water-sealed chamber which has a wide extended lip. Flowing from this trough in an even sheet it is distributed over a series of oppositely inclined finely perforated copper trays arranged one above another so that the water in its downward course falls from one tray to another and any water which does pass through the perforations will fall upon the protruding upper end of the next tray.

After leaving the lower tray the water falls into the second chamber below, to reach which, it passes through a downtake pipe to the under side of the filter and rises upward through the cast-iron perforated screen which holds the filtering material in place, through the filtering material and upper screen to the under side of the division plate, whence it travels to the pump outlet.

From the pump outlet the water is forced into the boiler by a Dean 7½ by 5 by 6 in. duplex pump. The heater is set well above the suction valves of the pump and takes its steam from a branch of the main exhaust pipe, simplifying the connection, so that all exhaust steam does not pass through the heater but just the quantity of steam needed and no more. The returns from the heating system are delivered by a vacuum pump to a vapor tank, from which a pipe connection is made to the water pipe leading to the heater, so that 2 sources of water supply are available. Exhaust steam is used for the heating system and for steam cookers, and exhaust from pumps is utilized by a water heater for house purposes, the arrangement being as seen in Fig. 2.

Generating Units

GENERATING units consist of 3 15 by 16 in. single cylinder Skinner automatic noncondensing engines rated at 150 hp. each, direct coupled to General Electric 3-wire, direct-current generators rated at 100 kw., 250 volts, 100 amperes. A corner of the engine room with 2 of the generating units is shown in Fig. 1. A continuous system of oiling and filtration is used on all 3 engines, as shown in Fig. 3. Starting with the separator at the end of the engine, the oil after passing through the engine, accompanied by stuffing box leakage in the shape of water, flows into the separator. This separator separates the oil and water; the water passing through an overflow pipe at the bottom.

No oil comes out of the overflow and no water reaches the oil tank, where the first cleansing of the oil takes place, the oil passing to the purifier, as shown by the arrow, where it is freed of all foreign substances and then passes to the supply tank shown

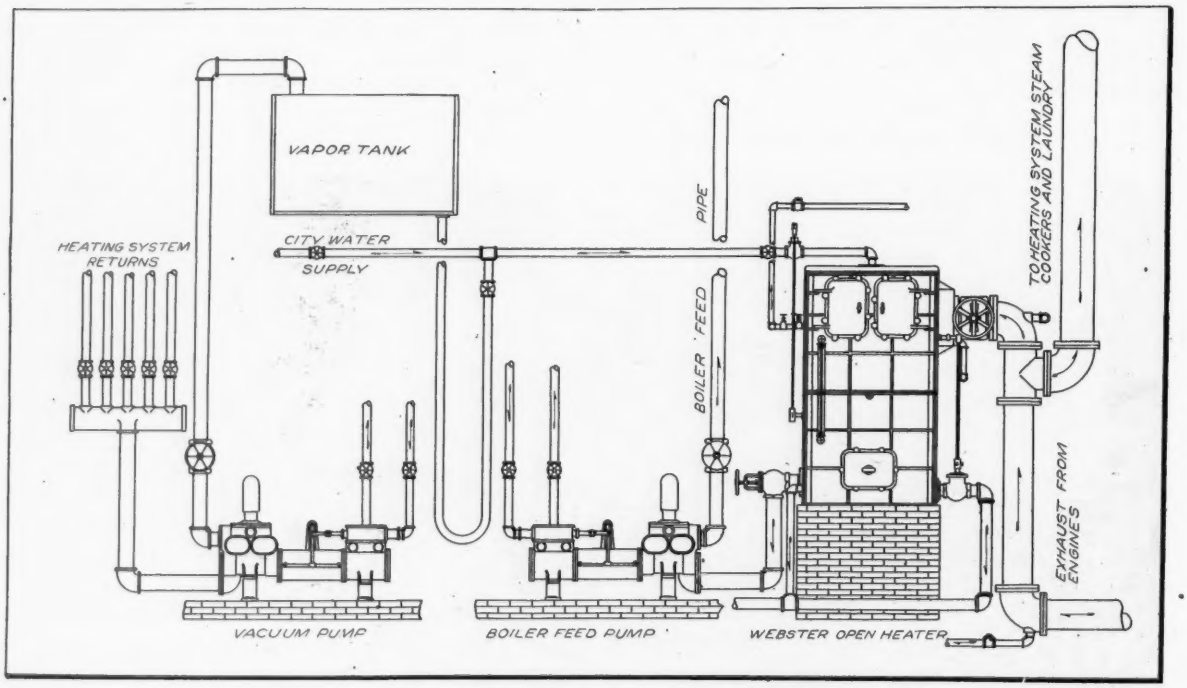


FIG. 2. FEED WATER HEATER AND FEED WATER PIPING

on the side of the engine sub-base, which is separated from the purifier by a partition. A pump of unique design having a positively moved valve which is noiseless, forces the oil directly to the tank and guide feeders. An oil feeder overhanging the guides is hinged to a stand bolted on top of the bed; through this the oil is conducted to the sight-feed glasses placed on the guides, and is then conveyed, by means of oil chambers, to both the guide and crosshead pin.

To 2 strands placed near the main bearings is hinged an arch-shaped feeder, through which the oil is conveyed to sight-feed glasses placed in the pillow block caps above the shaft. The oil is conducted to the shaft boxes and thence, by means of oil channels drilled through the shaft, it is thrown by centrifugal force to the crank pin. When the engine is shut down, these jointed feeders are raised to the position shown by the dotted lines, the oil supply is shut off and when in this position, ready access to any part of the engine is thus afforded.

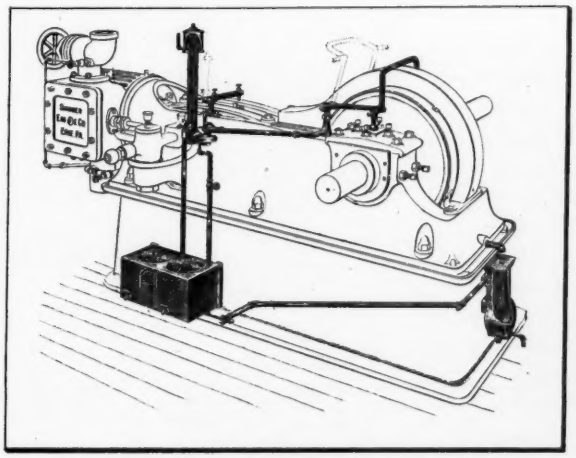


FIG. 3. DETAILS OF AUTOMATIC OILING SYSTEM

The 3-wire generators are provided with 2 collector rings mounted at the commutator end of the machine, which are connected to the proper points in the armature winding. The brush rigging for the collector rings is supported from the direct-current brush holder studs and is connected through copper brushes to a compensator for each machine. The compensators consist essentially of 2 insulated coils wound on a laminated iron core, the whole being enclosed in an iron case. These compensators are designed for a neutral current of 25 per cent full load generator current, this value having been found ample for practically all conditions of service.

The compensator carries an alternating current and serves to maintain a neutral potential at its middle point, which is connected to the middle wire of the 3-wire system. The switchboard consists of 4 panels, 3 generator panels and one feeder panel. The generator panels are equipped with 3-pole main switches, ammeters, voltmeters, field rheostats and field switches.

Elevator and Miscellaneous Load

THERE are in the Onondaga Hotel the following Otis elevators: Two electric worm-gear traction passenger elevators, driven by 25-hp. d.c. motors; one electric drum type freight elevator driven by a 12-hp. d.c. motor; one electric drum type service elevator, driven by a 7.5-hp. d.c. motor; one hydraulic ballroom elevator; one hydraulic plunger trunk lift; one hydraulic plunger freight lift; a hydraulic plunger freight elevator; a hydraulic plunger ash lift and a hydraulic plunger bar lift.

Besides the refrigerating plant and elevators, 80 hp. is used for ventilation and the laundry. Electric drive is used throughout the building, and there are 4000 tungsten lamps varying in size from 20 to 150 watts.

Ventilation of the office and kitchen is effected by the Plenum system, manufactured by the Buffalo Forge Co. This system provides for the use of a fan blower which takes its supply of fresh air from the outside of the building, forces it over steam coils and then into the ducts leading to the rooms. The movement of the warmed air is positive and the delivery of the air to the various points of supply is certain and entirely independent of atmospheric conditions. The fan is 14 ft. in diameter and 4 ft. wide, is motor-operated and delivers 10,000 cu. ft. of air a minute.

FIG. 4. ONONDAGA HOTEL, SYRACUSE, N. Y.

Plant Records

THE daily log sheet, shown in Fig. 5, records the time of starting and shutting down engines Nos. 1 2 and 3, the 2 ammonia compressors, circulating pump, boiler feed pump and vacuum pump; cylinder and lubricating oils used and details of repairs. Record of the coal received, in pounds, meter readings for water at 2 entrances, and gas.

Provision is made for recording the supplies received, time of outside help, also the number of hours each engine room and boiler room employe is on duty during the 24 hr. At the bottom, space is left for enumerating the house repairs.

The form shown in Fig. 6 is a monthly summary of the daily logs and gives the average cost per day

for operating the entire plant. As all water, steam and gas used for cooking, heating, house and laundry purposes are charged against the plant, the cost of power is not figured at the switchboard.

Refrigerating Plant

THE refrigerating system consists of a combination of direct expansion and brine circulation, and was installed by the Frick Co., Waynesboro, Pa. The 2 Frick "Eclipse" compressors have 10 and 15 tons capacity respectively, the compressors consisting of a

THE ONONDAGA HOTEL.

DAILY LOG COMMENCING 7 A. M. 191

Engine	Started	Shut Down	Oil Used Cyl.	Oil Used Lub.	Waste	Repairs and Remarks
No. 1						
No. 2						
No. 3						
Frick No. 4						
Frick No. 10						
Circulating Pump						
Boiler Feed Pumps						
Vacuum Pump						

Supplies to

Total for the day

Coal received	No.	Meter Readings	Water, Warren St.	Water, Jefferson St.	Gas

Supplies Received

Outside Help

Engine Room Help	hours	Boiler Room Help	hours	Boilers	
				No. 1	
				No. 2	
				No. 3	

Home Repairs

Chief Engineer.

FIG. 5. DAILY LOG SHEET

pair of single acting ammonia cylinders driven by horizontal steam engines, all forming a part of one structure. The 15-ton machine is driven by an 8½ by 12 by 12 in. Frick "Eclipse," non-condensing Corliss engine; ammonia cylinders are 8½ in. in diameter, with 12 in. stroke. The 10-ton compressor is driven by a piston-valve engine, and the cylinders are 6½ in. in diameter with 8-in. stroke.

A novel feature of the compressors is the bypass shown in Fig. 9, one of which is located on the pump platform of each compressor, enabling the engineer to exhaust the ammonia from any part of the system; stop valves are furnished to isolate every part, and temporarily store the ammonia in any other part until repairs or examinations are made. The bypass is also used for exhausting the pumps themselves before the heads are removed for examination. By means of the peculiar arrangement of pipes and valves, the engineer is able to reverse the action of the pumps and exhaust the ammonia from the condenser, storing it in the expansion coils.

In each case after the examination of any part, the air may be exhausted therefrom, and the charge of ammonia is re-introduced without the admixture of air. The bypass valves are closed while the machine is on regular duty.

Pump pistons are gas tight yet move freely, compensation for the wear being provided by using 5 spring rings which are carefully fitted. A steel suction valve is situated in the piston, the gas inlet being in the base of the pump. The suction valve is balanced by a spring and presents, upon the return stroke of the piston, no resistance to the gas which flows under the back pressure, with considerable velocity into the vacant space above the piston. A cushion and spring assist in closing the suction valve promptly and noiselessly as the up-stroke is begun, the imprisoned gas being gradually compressed until it equals the condensing pressure, acting upon discharge valves located in the pump dome, then discharge begins.

THE ONONDAGA

.....REPORT POWER DEPT.

Coal on hand 1st of month	*Tons*		
" *received*	"		
" *on hand last of month*	"		
" *burned*	"	*Cost $*	
Ice manufactured	"		
" *purchased*	"	*Cost $*	
Supplies purchased		"	
Waste used	.....*Lbs.*	"	
Wiping cloths used	..... "	"	
Oil, cylinder "	.....*Gal.*	"	
" *lubricating*	..... "	"	
Grease used	.....*Lbs.*	"	
Boiler compound used	..... "	"	
Lamps used	.....	"	
Repairs		"	
Outside labor used for repairs		"	
Regular "		"	
		Total	

Average per day

Water used	.....	*Cubic feet*
Gas "	.....	" "
Equipment Purchased	*Cost $*.....	
Outside labor for betterment	"	

Remarks.....

.....

.....

.....*Chief Engineer*

FIG. 6. MONTHLY REPORT BLANK OF POWER PLANT

Gas under the treatment it receives in the compressor pump, parts with more or less of the heat of compression through the wall of the cylinder, the dome and cylinder being enveloped by a water jacket, through which the cold water is constantly circulating. In order to make it perfectly safe to work the piston metal to metal against the top of the cylinder head, the better to expel the full charge without danger, the pump head is made movable or is what may be called a safety head. In other words, it is simply a large valve, the full size of the bore of the pump, through the seat of which the piston may pass without injury, raising the head before it sufficiently, in the case of any parts getting loose, so that no danger may ensue, such as

knocking out a cylinder head. The safety head does not work as a valve, the real operating discharge valve being the valve in the center.

For cooling of the brine, throughout the hotel and in the various storage boxes and pipes, there is a brine storage tank 6 ft. in diameter and 8 ft. high with the necessary cooling coils. The brine is primarily cooled by an Eclipse triple-pipe brine cooler 25 ft. long and 55 in. high. The design and construction of this brine cooler secures a transfer of heat from the brine on its way from the brine circulating pump to the refrigerating pipe coil system with the least loss of pressure through friction and a positive circulation in contact with the ammonia vaporizing surfaces, and obtain the lowest temperature of brine with ammonia vapor pressure higher than that obtained through the usual method for the same temperature of brine.

A triple-pipe brine cooler consists of 3 pipes, which we will designate as inner, intermediate and outer, to indicate the relative positions and sizes. Each cooler stand is made up of a number of sections having an inner pipe fitted in the center of the intermediate pipe, and this in the center of the outer pipe; the annular space between the inside of the outer pipe and outside of the intermediate pipe is connected by special return bends on sections through the entire stand. The brine enters the cooler stand at the end of the lowest section, flows through the outer annular space the

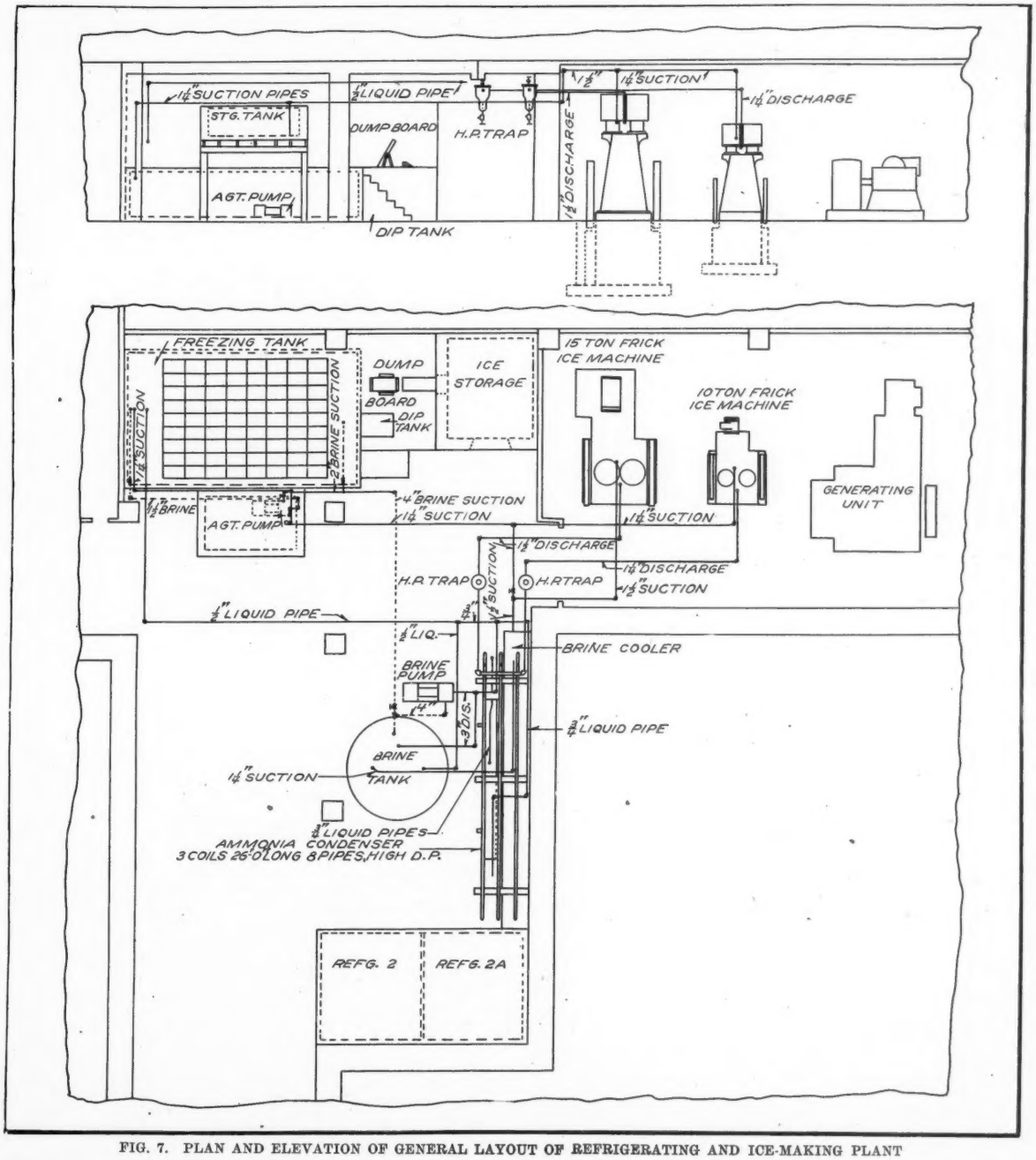


FIG. 7. PLAN AND ELEVATION OF GENERAL LAYOUT OF REFRIGERATING AND ICE-MAKING PLANT

full length, and through the special return bend at the next section, and so on to the end of the top section, where a special connection is made with the inner pipe of the top section, and flowing the full length, is delivered through the return bend to the inner pipe in the next lower section, and so on to the cold brine discharge.

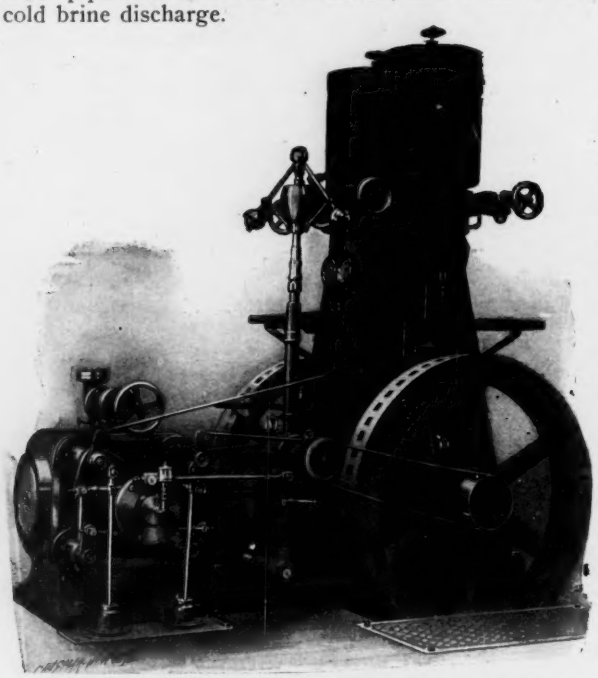


FIG. 8. FRICK 15-TON SINGLE ACTING, STEAM DRIVEN AMMONIA COMPRESSOR

The cooling of the brine through this travel is effected by the expansion of ammonia liquid fed into the intermediate annular space that is enclosed between the outer and the inner conduit. The ammonia expansion conduit is connected by special return bend to the next section, and so on to the top section, where the gas is delivered to the ammonia gas return line. The flow of ammonia being in an opposite direction to that of the delivery of cooled brine, the transfer of heat to the ammonia and consequent cooling of the brine are secured by the efficient arrangement of greatest surface and closest contact in transmitting elements.

Figure 10 is an illustration of the Frick triple-pipe brine cooler, and will give a good idea of its construction. The cooler may be located in the engine room, if desired, but it should be insulated and may be placed in an insulated storage room if preferred.

Condenser

THE ammonia condenser is the Eclipse double-pipe type, consisting of 3 coils 20 ft. long and 8 pipes high, 18 in. between coils, and is especially suitable for use where the water is to be used for other purposes, as it is available at circulating pressure at discharge from the condenser without change except increase in temperature.

The current of cold water entering the condenser at the lowest point meets the coldest gas, and as the flow of gas and water is in opposite directions the water becomes warmer as it meets the warmest gas. Each stand or coil of these condensers contains inner pipes having an internal diameter of 1½ in. for condensing water and concentric with this an outer pipe having internal diameter of 2½ in. This annular space forms the conduit for the ammonia gas, securing rapid transfer of heat and close contact of circulating water, preventing pockets and undue friction.

Each stand or section is provided with ammonia stop valves on the ammonia gas inlet and liquid discharge, also a special air-purging valve on the highest point of the ammonia condenser and substantial wrought-iron stands securely bolted in place.

Figure 7 is a plan and elevation of the refrigerating and ice making plant, showing the location of the compressors, the brine cooler, brine tank, ice tank, etc. Brine is circulated by a 6 by 15 by 15¾ by 6 in. brine pump. The discharge and suction pipes for the 15-ton machine are 1½ in. and the 10-ton machine 1¼ in. in diameter, with high-pressure traps introduced into the discharge of each compressor. The ice tank has a capacity of 2½ tons and supplies ice used in the dining room and cafe. The tank is 17 ft. 6 in. long, 10 ft. wide and 4 ft. high and contains the necessary extra 1¼-in. evaporating coils. The tank contains 72, 100-lb. cans, 8 in. by 16 in. by 32 in.; the brine is agitated by an agitating pump 4¼ by 3 in. by 4 in.

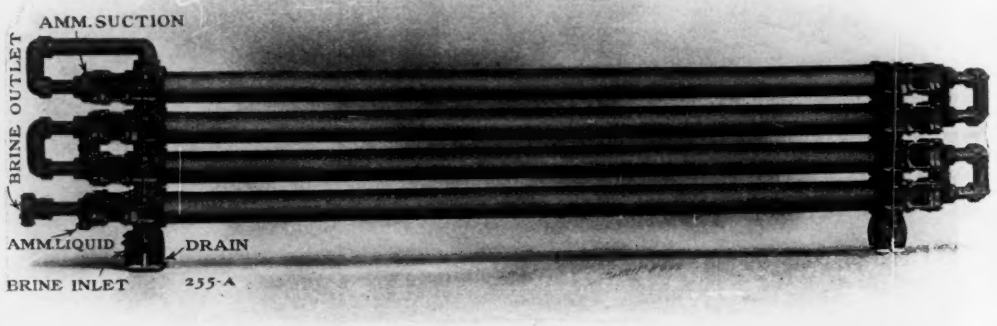


FIG. 10. TRIPLE-PIPE BRINE COOLER

Tank or Precooler

A WATER storage tank 4 ft. by 7 ft. by 30 in. high is located adjacent to and a little above the ice tank and contains the ammonia header for the circulating coils in the brine. The water tank acts as a precooler lowering the temperature of the water before it enters the ice cans.

Raw water is utilized in the manufacture of ice and a brine temperature of about 20 degrees is maintained which it is claimed gives pure solid ice with raw water.

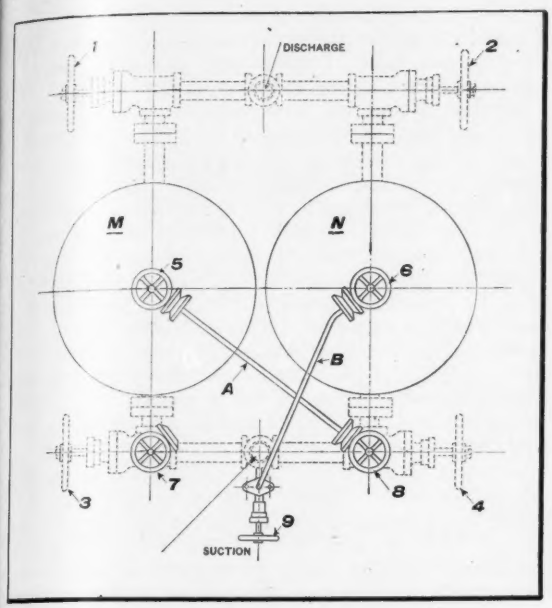


FIG. 9. COMPRESSOR BYPASS

The electrical, steam, heating and ventilating apparatus was installed by the Edward Joy Co., Syracuse, N. Y.

ELECTRIC PASSENGER ELEVATORS

Points in Regard to Safe Operation; Causes of Falling, Locking and Jamming

By Wm. Kavanagh

ELECTRICALLY operated elevators for both passenger and freight service are now growing in favor, their low cost of installation, ease of operation, smoothness of motion, together with their inability to "creep," thus eliminating the cause of numerous accidents, have all combined to make the electric type of elevator the choice, in many instances, of machines for the raising and lowering of either passengers or freight in building. The maintenance of high-speed passenger elevators requires the attention of competent men who are familiar with the mechanism, and the services of such men should be utilized during the running hours of the cars so as to insure their safe operation.

Assuming our elevator car is raised and lowered by the worm gear and drum, particular attention should be given to these members of the mechanism so as to prevent cutting and excessive wear, which will surely occur if not properly lubricated. The casing which contains the worm and gear has a door situated either on its top or one of its sides for the purpose of inserting oil or worm gear grease; this form of grease is an excellent lubricant to use, because it will not become so thin as to leak out rapidly through the stuffing box. The worm gear should be oiled once in every 2 weeks to insure a sufficient quantity of lubricant in the casing at all times.

Tripping the Governor

THE governor should be tripped once in each week, but in doing so it is not necessary to spring the gripping mechanism when the car is in motion. When the governor is tripped and the car is in motion the safety cable becomes "kinked" and in some cases a torn strand will develop, thereby causing the safeties to act at the most inopportune time, as well as a renewal of the safety or governor rope.

After we have learned the safety clutches act, it will be found sufficient to trip the governor when the car is at rest; particular attention should be given to the safety rope when the governor has been tripped and the pressure should be great enough to prevent a man from slipping or pulling the rope through the gripping mechanism.

A very serious mistake occasionally made is the use of too small a safety rope; when such is the case the gripping mechanism will be enabled to lock the rope at the precise moment, and although the governor acted to trip the mechanism, the car will fall and probably take the life of or injure persons riding at that moment. From the above it will be seen a safety rope of the proper diameter is an important factor for the prevention of accidents.

When a car drops without its cables breaking, 4 causes may combine to have it do so. First, a car may drop because of too great a load, overcoming the brake friction; second, the inability of the governor to act; third, the diameter of the safety rope being too small; fourth, the safety rope may be in poor condition and break at the moment when the strain is applied.

When a car is overloaded on the downward motion, its speed will be accelerated, thus causing the governor to act and grip the safety rope; when this occurs the safety clutches will be sprung, thus locking the car in any part of the shaft.

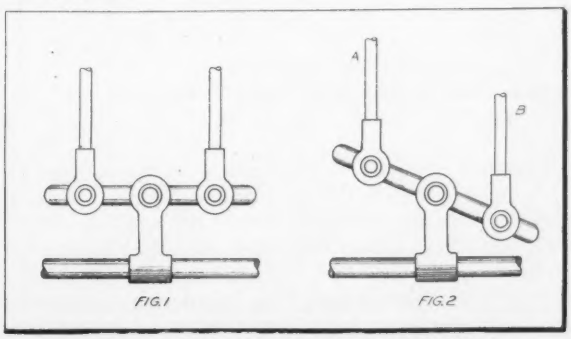


FIG. 1. EQUALIZER FOR ELEVATOR CABLES
FIG. 2. INDICATION THAT CABLES ARE NOT OF EQUAL LENGTH

To get the car running once more, the first thing to do is to take up the slack of the hoisting cables before attempting to release the clutches. After the slack has been taken up the clutches can be pulled off; the operator should throw his controller on the upward motion, thus insuring the taking up of any slack that may have remained in the cables. When a car is clutched in the shaft and it is filled or partly filled with passengers, the work necessary to unclutch the car should be done quickly and with the least amount of shouting or loud talk, as such is very liable to cause excitement among the passengers.

Sometimes it will be found a car will become locked in the shaft without any apparent reason, even though the car is not overloaded and in the hands of

an experienced operator. The difficulty in this case will usually be found in the governor; it may be set too sensitive, thereby causing an unnecessary gripping of the safety rope; another reason why cars are often "stalled" in the shaft is lost motion in the weight connections or a lessening of the spring tension that holds the weights against centrifugal action. Any undue increase of speed will cause the weights to travel beyond their regular plane, thus tripping the gripping mechanism and clutching or stalling the car.

When the hoisting cables are under unequal strain, the shorter cable will have to do the most work. If we want both cables to do same amount of work, we should adopt the equalizer or balance lever, as shown in Fig. 1. When both cables are under the same strain, the equalizer will be parallel with the roof of the car throughout its entire journey from the lowest to the highest stop; when, however, the cables have an unequal pull, the balance lever will become angular to the car roof or cross beam, as shown in Fig. 2. Cable A being shorter, will pull down on B and thus B is compelled to sustain its portion of the load.

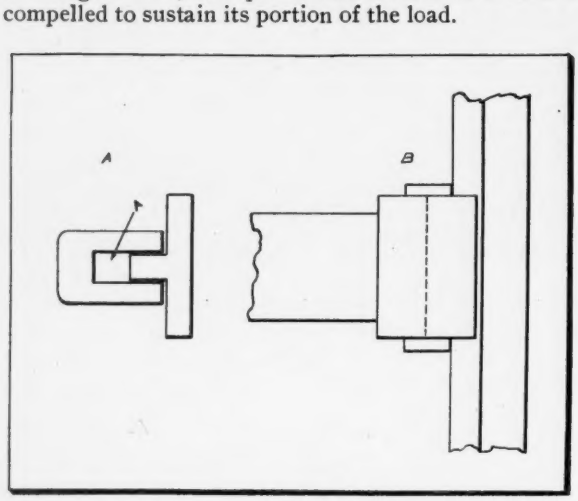


FIG. 3. CAR SHOE WITH MEANS FOR TAKING UP WEAR

Unequal tension on the cables is caused by the following conditions: First, unequal lengths; second, a difference in the circumference of the winding drum; third, one of the cables may have stretched more than the other.

It will be seen the use of the balances as mentioned above compensates for all of the above inequalities and its employment is very essential to the safe running of an elevator car.

An important feature of an elevator car is smooth running; a jerky, noisy motion often causes complaints from nervous passengers.

In cheaply constructed cars no means are afforded for taking up the wear of the car shoes. Fig. 3A shows a simple plan to adopt when shoes are worn and causing trouble; the worn shoe is removed and a brass or babbitt gib or liner is inserted, as shown at A. Figure 3B illustrates the gib in position and ready to move along the guide rail; by employing such a contrivance a smooth running car is obtained, providing the rail and gibs are well lubricated.

There are several shoe lubricators manufactured for this particular purpose, use of which insures a smooth running elevator car.

STEAM TURBINE OPERATION

By Thomas Sheehan

THERE is very little printed in engineering papers about the operation of steam turbines, which are fast replacing the reciprocating engine for many purposes, and I give the following practical rules as they are applied in our plant:

To start a 3000-kw. Westinghouse Parson, double flow steam turbine, running at 1500 r.p.m., exhausting into a Leblanc condenser, the 24-in. atmospheric valve operated by hydraulic pressure, the governor acting on an oil relay mechanism which controls poppet valves for the admission of steam; after the valve gear is oiled, the independent oil pump is started and the oil pressure gages show about 50 lb. for the governor and 3 lb. pressure for the bearings, see that the drip valves are opened, also the atmospheric valve. The throttle valve can now be opened until about 5 lb. shows in the inlet gage, and steam is allowed to blow through for a few minutes, but it is better not to have it blow too long, the spindle and blades warm up more evenly when the turbine is turning.

To start it revolving, about 75 lb. inlet pressure will be required. When started, the throttle valve should be closed, and the turbine gone over for any signs of rubbing; this is best done with a hard wood stick about one foot long; put one end against the ear and the other end against the turbine casting, and any rubbing can be heard and corrected in the trust bearing. Then the throttle can be opened until about 15 lb. shows on the inlet gage. While the turbine is gradually gaining speed, the condenser can be got ready, bearings filled with oil, valve in the suction pipe leading to the air pump opened a few inches, also the priming water turned on. The condenser engine can now be got up to speed, and the diffuser valve opened, this admits steam to an injector in the discharge of the air pump.

When the turbine reaches about 1000 r.p.m., the gland water can be turned on, which seals the ends of the spindle. The independent oil pump should be slowed down as the oil pump in the turbine, run from the spindle, will be taking hold. When the drip valves are closed, also the atmospheric valve, the vacuum will come up; this can be helped along by closing down on the throttle, when the vacuum is high enough to lift the water from the source of supply, the injection valve can be opened, about 5 lb. inlet will bring it up to full speed. The diffuser and the priming valves can be closed and the independent oil pump shut down.

After a little practice the turbine can be started and put on the line in about 10 min. The oil relay valve can be operated to make the poppet valve travel from wide open to the closed position to see that they are not sticking. The primary valve will take care of about the rate capacity of the turbine, when the secondary valve should be adjusted to open, or when the arms of the valves are in a horizontal position. The secondary valve is adjusted in a slot by a screw.

To shut down, trip the over speed device, which closes the poppet valve, also the throttle valve disk, the hand wheel of which can be closed down later; admit water to the bottom of the auxiliary piston of the atmospheric valve, start the oil pump and open the drip valves and shut down the condenser.

Asbestos cement is made by mixing finely ground asbestos with a concentrated solution of silicate of soda to form a thick paste.

LOCK GATES OF THE PANAMA CANAL

Machinery Used to Operate the Locks and Details of Construction

By A. P. Connor

THERE are 46 gates for the locks of the Panama Canal, each of which consists of 2 leaves of steel approximately 74 ft. high, 65 ft. wide and 7 ft. thick. The leaves are made in sections and present a front and rear wall of steel to the water, suitable bracework being placed in between to strengthen the gate and to divide it interiorly into a number of compartments. In general, the upper half of each gate is a water chamber and the lower half an air chamber. In addition, means are provided to make the gate close water-tight, and also to permit operators safely to cross the shut gates.

It can be readily appreciated that it is not an easy problem to provide an arrangement which will make such gigantic gates move satisfactory under any conditions, but especially under severe conditions that will arise in the Panama Canal locks. The lock gates do not close straight across the locks, but meet at an angle, so that they form the hypotenuses of right-angled triangles, having a perpendicular of 1, and a base of 2 units. The space across the locks is 110 ft.

A number of schemes were proposed and that which appeared to be the most satisfactory, selected. Then a model of the scheme was made and tried out, and proving successful, was adopted. The arrangement is interesting from many points of view, and particularly in the manner in which it provided for the stresses it has to stand and meet. In the first place, a crank and connecting rod arrangement is used, the crank being practically a large gear wheel over 19 ft. in diameter. This wheel or crank is operated through a train of gears by a 35-hp. motor running 500 r.p.m. The angular turning movement of the crank is about 190 deg. from the open to the closed position of the leaf which it operates. The pinion on the motor shaft engages with a spring center gear which is 4 times as large, and serves to take up the stresses at the starting of the gate. This gear causes a pinion on the same shaft to rotate another large gear which in turn causes its shaft to operate a bevel pinion which engages with a large bevel gear having spur gears on its shaft for turning the crank wheel, and thus forcing the connecting rod or strut to operate the gate leaf.

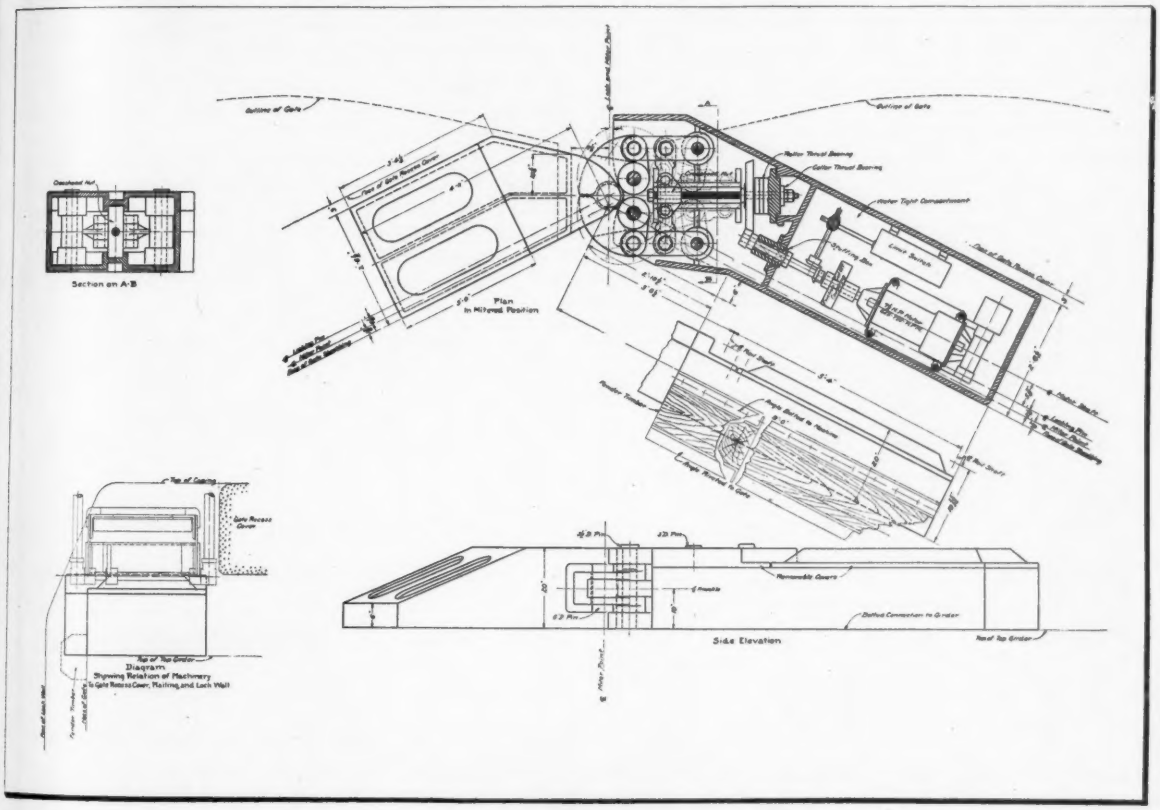


FIG. 2. DETAILS OF THE MITERING LOCK GATES

The connecting rod or strut terminates in suitable ring couplings which are rotatably connected to pins on the gate leaf and crank, and means are provided to give the necessary adjustment that it may need in its length. By means of a sleeve spring buffer arrangement in the coupling attached to the gates, means are provided whereby a certain amount of flexibility is provided, which enables the strut to be effective and at the same time protected from dangerous stresses.

Each machine for operating the pair of leaves of a gate, acts simultaneously, and even if they do not,

the miter ends of the gates will permit the leaves to close tightly together eventually. The relation of the strut and crank is such that a toggle effect is produced near the ends of the travel and the motor

The cut-out switch is mounted on one of the telescoping members while a rod entering the switch casing is attached to the other. The movement of this rod in and out of the casing operates the switch

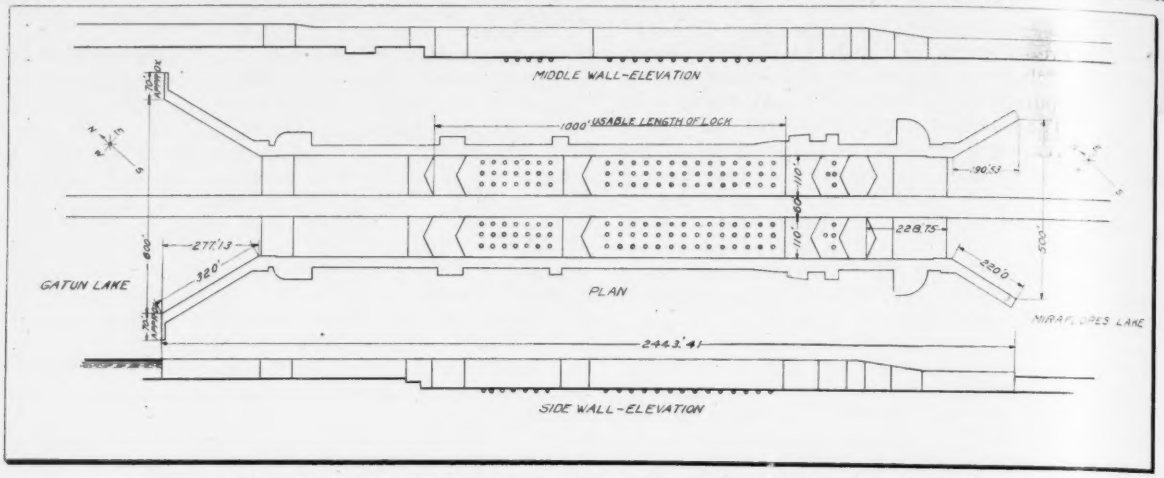


FIG. 1. GENERAL PLAN AND ELEVATIONS OF THE LOCK GATES ON THE PANAMA CANAL

would be capable of doing damage to some of the parts should the gate meet with an obstruction. In order to avoid such a difficulty an auxiliary cut-out switch is provided. This switch is of a double throw style and works when the strut is compressed or extended abnormally, which extension and compression is permitted by the nest of springs in the buffer and of the strut. This would of course be the case when the gate met with a solid obstruction near either end of its travel.

to open the control circuit and stop the motor. It is necessarily arranged so that, if the switch is operated by compression of the strut, that side of the control circuit is opened which produces a rotation of motor corresponding to compression, and the other circuit remains unbroken for reversing or drawing the gate away from the obstruction; and if operated by tension and the motor is stopped, it must be possible to reverse and apply compression to the strut. The switch will operate with about 2 in. travel either

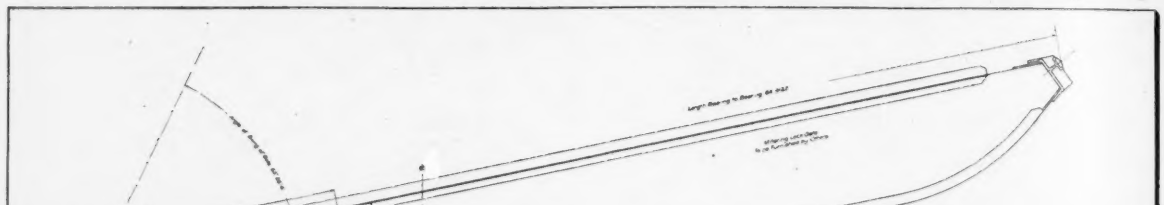


FIG. 3. MITER GATE MOVING MACHINE

way from the mid-position, with suitable means to adjust it so it will move as desired.

After the leaves are mitered or closed, a special motor on one of the leaves is started by the operator, which through suitable gears and mechanisms operates a catch of pawl-like form and causes it to engage with a slotted receiving member on the other leaf. This locks the gate and keeps it closed, and at the same time takes the stresses off of the struts and gate operating machinery. The circuit of the miter-forcing machinery is controlled by a commutating switch operated by the miter gate moving machinery so that the lock or miter forcing machinery will not be operated until the gates are actually closed. The reason for this is obvious, because it can be readily seen that if this machinery started before, it might jam the catch in between the gates and keep them from closing. The commutating switch has other functions which are to alter the circuits controlling the rising and falling of the handrail for the foot-walk on top of the locks; so that should the gates be up when gates start to open they will be automatically lowered; and the circuits for raising the handrail are disconnected so that they cannot be opened as long as the gates are open.

If the handrails were allowed to remain up when the gates are opened back into the recesses of the lock wall, the handrails would interfere with a passing towing locomotive.

All the machinery for the locks is of a very substantial nature and made capable of withstanding severe strains, and in addition, most of the smaller parts, like bolts and nuts, are made of bronze to withstand the effects which the moist atmosphere of the Zone would be apt to produce on like parts if of steel or iron.

TWO AND TWO ARE FOUR—SOMETIMES

THE chief engineer was tired of firemen who claimed to be "old timers" at the game, and so he hired a youngster, fresh from the farm. The new man was a hard worker and had some intelligence. He soon learned to keep the steam pressure up, and always managed to have the water showing somewhere in the glass, while the boiler room shone with fresh black paint and polished brass.

The plant took a contract to heat a neighboring hotel for the winter, and on the first cold day the chief told the fireman to put on another boiler in the morning. The watch engineer helped the fireman cut in the boiler in the morning and when the chief came through everything appeared to be all right, in spite of the cold outside.

About 10 o'clock the fireman came into the engine room where the chief was talking to the manager.

"Well, how goes it with two boilers, Ed?" inquired the chief.

"Not very good," replied Ed. "Yesterday I had only 100 lb. of steam and it went all right, but today I have 200 lb. and it takes an awful lot of coal."

The manager's hair rose on end and he fled with visions of sticking safety valves and boiler explosions. The chief hurried to the boiler room. Everything appeared to be all right. The hands on the gages pointed steadily to 100 and the safety valves were gently sizzling.

"Where is your 200 lb.?" demanded the chief.

"Well," replied Ed, innocently, "there is 100 lb. on No. 1, and 100 lb. on No. 3, and if that 'aint 200 lb. on the both o' 'em, I eat my suspenders."

Dan Royer.

A CHANGED EXHAUST VALVE*

Improvement Made Where the Exhaust Passage Was Too Small Area

By W. Senge

IN September, 1906, I took charge of the steam plant for the Hasbrouck Flooring Co. In this plant was an old type 2-valve engine with cylinder 18 by 28 in., running at 110 r.p.m. The steam pipe was 5 in. and the exhaust pipe 6 in., the engine having 2 eccentrics and a fly-ball governor. By inquiring I found that this engine was installed in May of that year, second-hand, and was supposed to be overhauled and rebuilt, but it ran badly and had been shut down frequently for want of steam.

I looked over the boiler and found it to be a 16-ft. return tubular, with 70 4-in. tubes, rated at about 96 hp. As soon as possible I went through the factory to see what power it ought to take to run the plant, and to my surprise found that 60 hp. ought to be the maximum, or possibly, for an hour or two a day, 80 hp. I knew that a boiler which carried 70 lb. pressure should give plenty of steam to keep the engine running at full speed under this load, and I, therefore, looked at the engine as the reason for the shut downs. It was my business to keep the engine

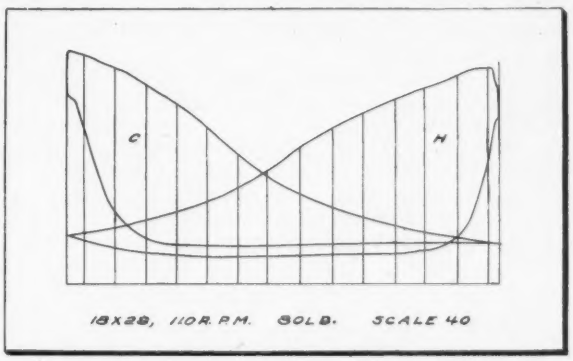


FIG. 1. FIRST CARD FROM THE ENGINE

running 9 hr. a day. Boiler feed was by means of an injector and water entered at 120 deg. Looking around the basement I found a feed water heater on the scrap pile, and on inquiring was told that it had been bought 2 months before but never put in place. Ordering some pipe and valves, I installed it the next Sunday, and by this means and stopping the air leaks around the boiler brick work, I got along very well that winter.

But in May of the next year a new tenant came into the building, who would want about 60 hp., and as in the changes about 60 hp. was required by other tenants, this meant that 120 hp. total must be furnished, and I knew that the boiler could not carry that load. I therefore got a second-hand boiler and put it in a place where the old boiler came out. The new boiler was 16 ft. long, with 140 3-in. tubes, and carried 100 lb. pressure. It could deliver about 150 hp. Thinking that there was something wrong in the cylinder or steam chest of the engine, I bought an indicator and Fig. 1 shows the first card taken. The valve was not set even, and there was about 14 lb. back pressure in the cylinder. I therefore opened up the cylinder to look for a leaky piston or valve.

*Presented before the Institute of Operating Engineers.

Putting the piston at the crank end and removing the cylinder head, I blocked the piston with a piece of timber to the rear wall, which was 4 ft. from the cylinder and admitted steam, but there was no leak between the rings and the cylinder wall. The only steam which could be seen came through the expansion holes. By sawing off the timber a few inches at a time and letting the steam act on the other side

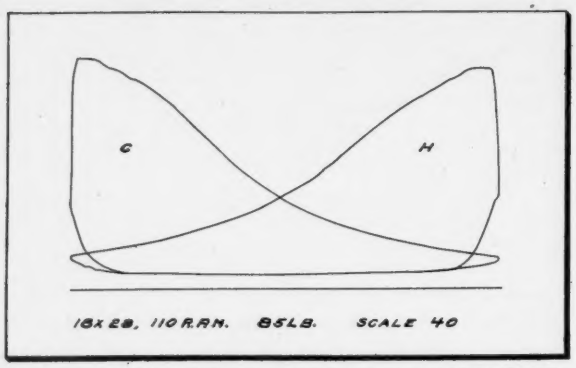


FIG. 2. DIAGRAMS AFTER EXTRA EXHAUST VALVES WERE ADDED

of the piston, I found that the piston and valves were tight throughout the stroke and for both ends of the cylinder, so that I had to look elsewhere for the cause of the back pressure.

I refitted the engine, started it up and put a low-pressure steam gage on the exhaust pipe and found only 2 lb. back pressure, which was not too much, as the exhaust steam is used for dry kilns and heating the house. There is about 4000 ft. of pipe in the heating system. The next thing was to look after the ports. I found them clear, but not satisfied, measured them. They were 12 in. long, by 1¼ in. wide, or 15 sq. in. area. Calculating the required area for the port by multiplying the area of the cylinder

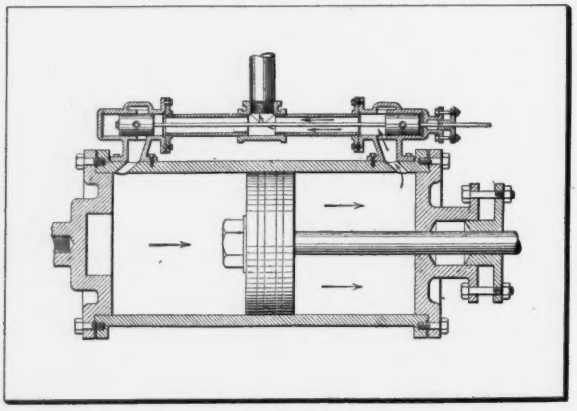


FIG. 3. SECTION OF CYLINDER AND EXHAUST VALVES

by the average piston speed in feet per minute, and dividing by the allowed velocity, 6000 ft. a minute, I found that the port area for the steam would be 22 sq. in.

The area of the piston is 254½ sq. in., the piston speed, 512½ ft. a minute.

For the exhaust steam, a velocity of 4000 ft. a minute might be used, and this would call for a port of 35 sq. in., whereas the port in this engine measured 15 sq. in.

Power was very irregular in the plant, because of the uneven speed, but as coal must be used to supplement the shavings for fuel, there was evidently a loss here which should be remedied. It was not possible to get the lessee of the plant to do anything to the engine to cut down this back pressure, and the plant ran along until July, 1911, when more machinery was installed. Whenever these machines were started with the others already running, the engine would slow down, and take steam full stroke and would draw water over from the boiler. Something had to be done. I had the draftsman make drawings for an exhaust valve which was cast, machined and put on the cylinder. The valves were of the piston type, each 3 in. in diameter, and the casting was set on top of the cylinder, one valve being at each end. The extra port I cut in the cylinder was 5 in. by 1¼ in. These openings and valves should have been larger, but as we did not expect more machines for the next 3 years, and as I did not wish to weaken the cylinder, they were made of the size stated. These valves are worked from the regular eccentric by means of a support and rocker arm. The diagrams, Fig. 2, were then taken with the ordinary load on the plant. When taking Fig 1, the governor weight was 18 in. from the fulcrum, and the engine made 106 r.p.m.; after making the change, the governor weight was moved to 10 in. from the fulcrum, in order not to overspeed the machinery in the factory, and the engine ran steadily at 110 r.p.m. at all loads. In Fig. 2, it would be better if the eccentric were moved ahead a little in order to give a straight steam line and an earlier release. After making this change I reduced the area of the grate under the boiler by 4 sq. ft., and the boiler gave plenty of steam.

SCIENTIFIC LUBRICATION

By Thomas O. Organ

DID not waste occur between the prime mover, which gets its energy direct from natural sources such as coal, gas or air currents, and the point where power is applied to do useful work, the power would be the same at all points in a machine or system and the efficiency would be 100 per cent.

Two classes of work are accomplished by the energy connected to the prime movers— Useful Work and Loss Work. Useful Work is that accomplished. Loss Work is the difference between useful work and the maximum amount of work done upon the machine. This difference of Loss Work is caused by absorption of power by friction and other prejudicial resistance of the mechanism. Friction is the main reason for energy wasted, and it is against energy wasted that scientific management is directed.

Since the adoption of electric power and electric motors directly connected to machines, engineers and owners of machinery have realized the necessity of cutting down friction loads, and today the most efficient lubrication is sought to lessen the enormous expense resulting from unnecessary friction.

Line shafting in particular is receiving unusual attention at present, both with regard to its lubrication and its alinement.

Unnecessary friction not only unduly increases power consumption, but the overheated bearings resulting materially add to the fire risk.

Lubrication of machinery at the present time is affected to a great extent by the use of oil, due to long-established custom.

Many devices, ranging from a simple oil hole to an elaborate force-feed system, have been invented for applying oil. The fluidity of the oil, is depended on to carry the greasiness to all parts of the bearing and the lubricating quality trusted to do the work, but many oils do not possess sufficient lubricating quality and are almost useless for the purpose, no matter how applied.

The value of an oil as a lubricant—other things being equal— is in proportion to its possession of that lubricating quality.

Oil lubrication must have constant attention if the engineer wishes to reduce friction to a minimum; the oil should be fed in uniform, adequate quantities—just sufficient oil to make the friction as low as possible.

The fluidity that causes a lubricant to flow readily into the bearing, causes it also to run out. As soon as the shaft begins to revolve, the oil is ready to escape, and soon finds its resting place outside the bearing, so that unless there is a constant feed, bearings become dry.

The late Prof. R. H. Thurston, of Sibley College, Cornell University, estimated the average loss in mill friction to be 50 per cent. This being the case, how much power is consumed to overcome the friction in shafting, which is oiled once every day, or once in every 2 or 3 days? In such cases, which are not uncommon, excessive friction must develop between the practically unlubricated shaft and bearing. This friction varies with the pressure—double the pressure doubles the friction, and so on. Some friction in mill shafting is unavoidable, but preventable friction is due to negligence, ignorance or poor judgment.

The problem has been to find something having the lubricating capacity of oil at its best and at the same time free from its shortcomings.

It is unfortunate that some makers and dealers have marketed various compounds made from a residuum of petroleum or from animal oil or both, thickened or filled with some substance of no lubricating value. In fact these fillers are often dangerously friction-producing and usually decidedly detrimental to whatever lubricating quality the oils with which they are compounded may have. Some greases are nothing more than soft soap with such a filling to give body.

The only purpose such ingredients can possibly fill is that of making a compound of low price to the consumer and of considerable profit to the maker.

Such greases depend upon frictional heat to melt them sufficiently to feed, and when melted, the compounded oils leave the journals as rapidly as plain oil, leaving only the filling or body in the bearing.

These fillers naturally fill up the grooves provided for distribution of the lubricant over the journal and prevent the action of whatever lubricating quality the compound may have.

These compounds have, of course, done but little to promote the greater use of grease for lubricating purposes.

But to-day it is possible to obtain pure petroleum grease having even greater lubricating efficiency than oil with the added advantage of cleanliness and ease of application and free from the objectionable properties inherent in the greases mentioned.

The fact is, that each user has it in his own power to settle all arguments as to the merits of various lubricants. As a rule, when a lubricant is placed as a sample to be tested, simply a casual observation is taken—there seems to be no thought whatever given to the amount of friction generated in the bearing so long as the plant will keep running. The only object seems to be to keep the plant going, disregarding the friction losses.

The best method of testing the value of a lubricant is by the use of a testing machine. The testing machine is so constructed that accurate readings of temperature, feet traveled, friction load and total pressure on the bearings may be taken. Such a machine will show very plainly the value of a lubricant. A testing machine of this description is very valuable to any one using large quantities of lubricants, as one may test out for himself the lubricating value of various lubricants considered.

On such a machine many tests of petroleum grease, tallow grease and engine oils have been made. All the grades, both of grease and oils, are widely known and considered first-class goods. A pure petroleum grease, with 3,000 lb. total pressure on the bearing, gave a friction load on the bearing of 38.8 per cent of one horsepower. Other greases with 2500 lb. total pressure on the bearing, gave 50 per cent up to 86.4 per cent of one horsepower friction load.

Some engine oils tested under a total pressure of 1500 lb., which was the highest that could be placed upon them, showed 38.6 to 62 per cent of one horsepower friction load.

Tests of the petroleum grease referred to above have shown a coefficient of friction of 0.00547 with a pressure of 214 lb. per sq. in. on the bearing, while sperm oil gave a coefficient of 0.0063 with 200 lb. per sq. in.

This shows that grease can be made and is made today that will reduce friction to a minimum. This petroleum grease is manufactured in various densities to suit the requirements of various machinery—heavy and slow-speed machinery, medium and light-running machinery.

The use of a first-class petroleum grease not only effects a saving in the cost of lubrication, but it cuts down the friction load—resulting in a reduction of the wear and tear on the machinery, and in the time and the attention required by the bearings. A grease manufactured from first-class petroleum stock will not gum or corrode the bearings, nor will boiling in water affect it. It does not contain any filler or body, such as above mentioned.

Consideration of these facts, shows very plainly that petroleum grease made in densities to suit the various classes of machinery is a most scientific lubricant.

SULPHUR ACIDS in fuels which are consumed under steam boilers or in internal combustion engines have a strong corrosive action. The effects of such action are well evidenced by the pittings, scales and roughened spots on metal surfaces that have been exposed to the products of combustion of fuels rich in sulphur. Therefore it is desirable to have an exact knowledge of the sulphur content of fuels in use. Technical Paper 26, issued by the Bureau of Mines, Department of the Interior, on "Methods of Determining the Sulphur Content of Fuels, Especially Petroleum Products," by Messrs. Irving C. Allen and I. W. Robertson, describes eight methods of determining the sulphur content and discusses their relative merits. This eleven-page pamphlet is issued as part of a report on petroleum technology.

THE BUSINESS OF QUEEN & Co., of Philadelphia, has been taken over by the Queen-Gray Co., of which J. G. Gray is president, and which will continue the sale of scientific apparatus at 618 Chestnut St.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

PRACTICAL ELECTRICAL ENGINEERING

Alternating-Current Generators, Mechanical Construction, Hunting and Its Remedy

SUCH generators are made to deliver or generate more than one alternating current, the currents always differing in phase, and known as polyphase currents; the only polyphase system in commercial use are the 2-phase and 3-phase systems.

Currents are generated in coils placed at different angles on the armature; thus in a 2-phase machine there are 2 sets of coils, the first set cutting the magnetic field at a maximum rate, when the induced

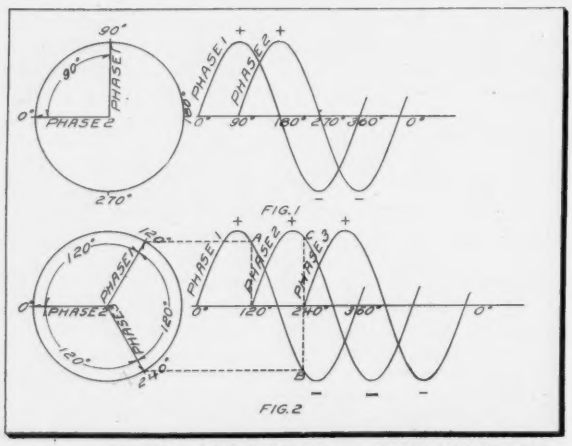


FIG. 1. GRAPHIC ILLUSTRATION OF 2-PHASE CURRENTS
FIG. 2. GRAPHIC ILLUSTRATION OF 3-PHASE CURRENTS

e.m.f. in the second set is zero. These currents differ in phase by a quarter period or 90 deg. as shown in Fig. 1, a system using such currents being called a "quarter-phase" system.

Figure 2 represents currents, where the phase relation is 120 deg. Phase 1 has completed its cycle as far as A when phase 2 starts at 0, 120 deg. behind phase 1. When phase 3 starts from 0, 240 deg. behind phase 1, phase 2 has completed its cycle as far as C and phase 1 as far as B.

The advantage of 2- and 3-phase alternating currents is principally that of operating induction motors. A polyphase machine has also a larger output for the weight of the machine than a single-phase machine. The relative advantage of the 2-phase and 3-phase systems, lies in the size of conductors required for the distribution of a given power.

Figure 3 shows a common method of connecting 2-phase windings; it employs 2 distinct circuits and 4 collector rings, the windings being represented by 1 and 2. The leads from A, A^1, B and B^1 are connected to the collector rings, but have no electrical connection with each other and form 2 independent circuits.

In Fig. 4 is shown a 3-phase winding known as the star or Y-winding, in which one end of each of the phases A, B and C is connected to a common center O and the other 3 ends are carried to 3 collector rings.

Instead of connecting the phases star or Y they may be formed into a closed circuit as shown in Fig. 5, the collector rings being connected to the points where the phases join. This form of connection is known as the delta or D, and like the star or Y connection requires but 3 collector rings. The relationship between voltage, ampere and watts is shown in the following rules:

In a 3-phase Y-connected alternator, the voltage between any 2 collector rings is equal to the voltage generated per phase multiplied by $\sqrt{3}$ or 1.732.

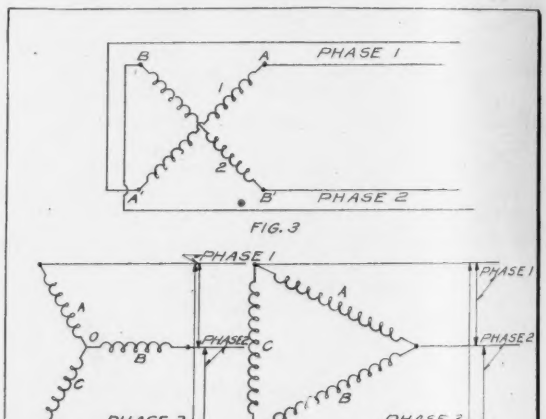


FIG. 3. ARMATURE WINDING OF 2-PHASE A.C. GENERATOR
FIG. 4. ARMATURE WINDING STAR-CONNECTED, FOR 3-PHASE A.C. GENERATOR
FIG. 5. ARMATURE WINDING DELTA-CONNECTED, FOR 3-PHASE A.C. GENERATOR

If the line voltage maintained on the line by a 3-phase Y-connected alternator is E volts, the voltage generated by each phase must be $E \div \sqrt{3}$ or $E \div 1.732$.

In a 3-phase Y-connected alternator, the current in each set of armature windings is the same as that in the line.

The output, in watts, of a 3-phase, Y-connected alternator working on a noninductive load is, therefore, equal to $\sqrt{3}$ or 1.732 times the product of the line current and line e.m.f.

In a 3-phase, delta-connected alternator, the line voltage E is equal to the voltage generated in each phase; and the current I flowing in the line is equal to the current in each phase multiplied by $\sqrt{3}$ or 1.732.

If the current in the line is I, the current the armature conductors must carry will be I divided by 1.732.

The watts output of a 3-phase delta-connected alternator working on a noninductive load is equal to $\sqrt{3}$ or 1.732 times the line current and line e.m.f.

Excitation and Mechanical Features

AS the field winding of alternating-current generator has to be supplied with direct current, some source of supply must be provided; this generally consists of a small d.c. generator which may be belted from a pulley on the alternator shaft, direct-connected to the alternator or may be driven by some prime move or an electric motor.

In Fig. 6 the connections of a 3-phase alternator and its exciter are shown. As the load on the alternator approaches maximum, the voltage drop of the line becomes greater and in order to compensate for this drop the alternator voltage must be raised. This is accomplished by cutting out some of the resistance in the alternator's field rheostat which allows more current to flow through its field winding. A field rheostat is also connected in the exciter's field circuit in order to maintain its voltage at a constant value with varying loads; the greater the current flowing through the alternator field winding the greater load will the exciter have to carry.

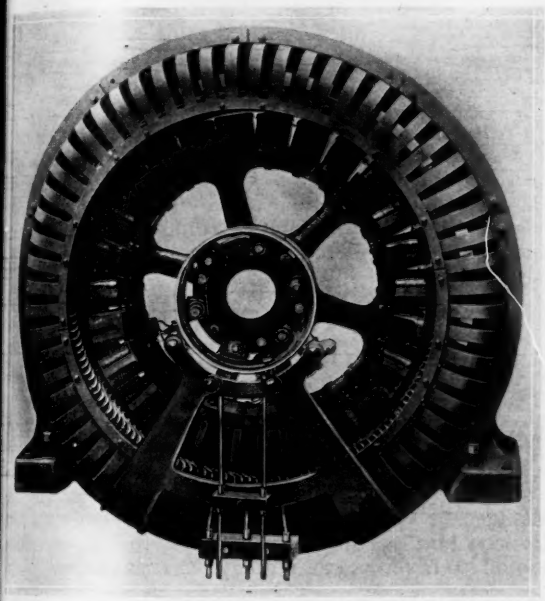


FIG. 7. THREE-PHASE ENGINE TYPE A.C. GENERATOR

In Fig. 7 is shown the revolving field of an engine type alternator. It will be noted that there are but 3 collector rings and these carry only low-voltage direct current for field excitation. The field magnet cores and the armature core are built up of thin sheets of soft iron or steel, the surfaces of which are coated with an insulating varnish, for the purpose of preventing induced currents being generated in the cores, which would result in heating and loss of efficiency. The combined spider and hub of the revolving field is generally made of cast iron with the pole pieces dovetailed as shown in Fig. 8.

Mechanically, alternators are divided into several classes, the principal divisions being belted type, direct-coupled type and engine type. In the latter type the revolving field is pressed on the engine shaft. An engine type alternator is shown in Fig. 9. Practically all modern alternating-current generators have stationary armatures and revolving fields; for high voltages it facilitates better insulation than can be obtained in a revolving armature.

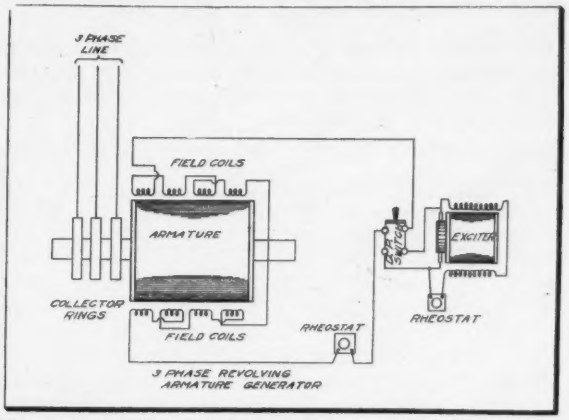


FIG. 6. CONNECTION DIAGRAM OF AN A.C. GENERATOR AND ITS EXCITER

Composite-Wound Alternators

IN studying d.c. machinery we have found that a compound-wound generator, either automatically increases its voltage with increase in load, as in the case of an over-compounded machine, or maintains a practically constant voltage under all normal conditions of load.

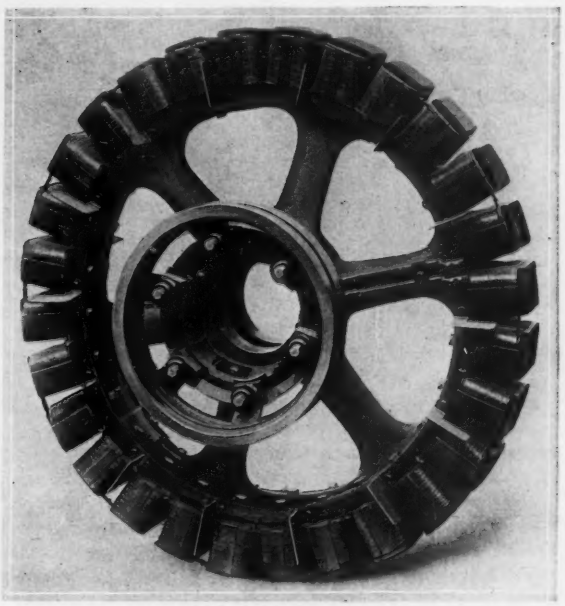


FIG. 8. REVOLVING FIELD OF AN A.C. GENERATOR

Composite-wound alternators are in effect similar to d.c. compound-wound generators; they are provided with a second field winding that is connected to

a commutator or rectifier, so constructed that a unidirectional current is sent through this winding in a direction corresponding to the exciter current in the regular field winding. The connections of a 2- and a 3-phase composite-wound alternator are shown in Figs. 10 and 11.

Parallel Operation of Alternators

FOR parallel operation of alternators and synchronizing see articles entitled "Synchronizing Alternators," July 1, 1912, page 670 and Aug. 1, 1912, page 770, of Practical Engineer.

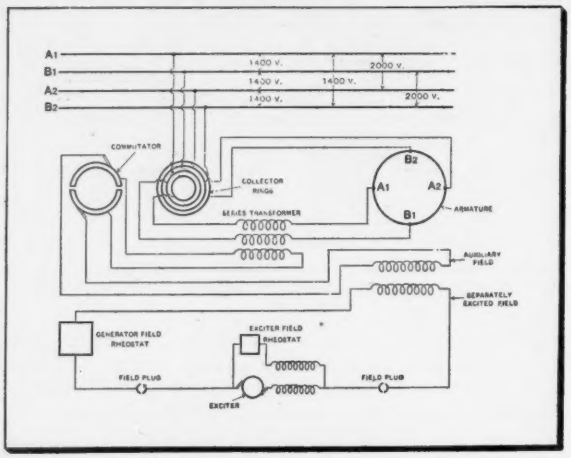


FIG. 10. CONNECTION DIAGRAM FOR A COMPOSITE-WOUND 2-PHASE GENERATOR

With alternators operating in parallel, any variation of speed in the prime movers tends to set up an oscillation or surging of the alternators, first one running ahead and then the other, resulting in cross currents between the machines of greater or less magnitude; this phenomenon is called hunting.

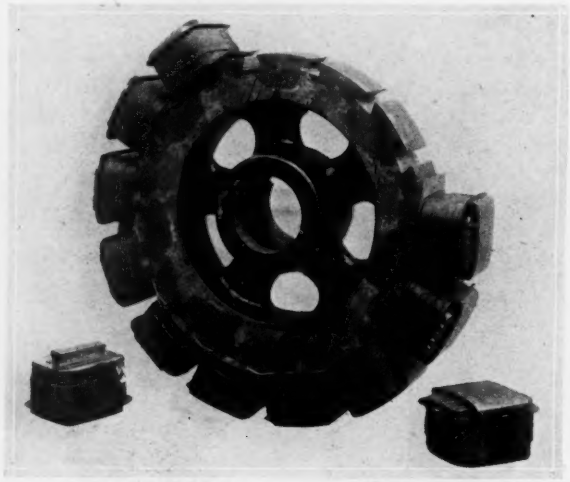


FIG. 9. CONSTRUCTION OF AN A.C. GENERATOR REVOLVING FIELD

To eliminate hunting as far as possible, the pole pieces of the field magnets are surrounded by copper bands, or have copper grids laid in slots in the pole faces, in which eddy currents are induced by the shifting and distortion of the field. These currents react on the field and oppose the shifting and thus damp the oscillations.

Reference Articles

THERE have been published in Practical Engineer, during 1912, several articles on the subject of alternating-current apparatus, so that it is not considered necessary to reprint the subject matter, as the articles can be referred to and should be read in the following order:

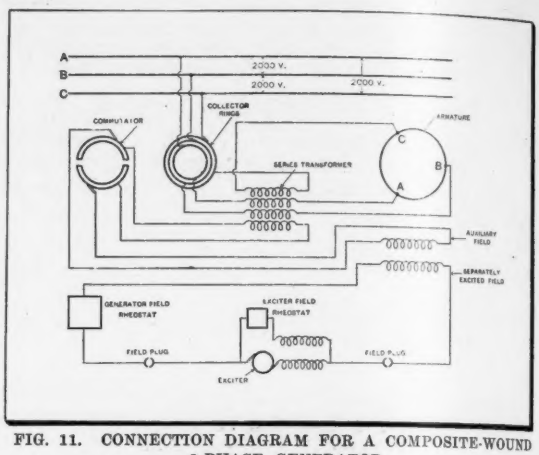


FIG. 11. CONNECTION DIAGRAM FOR A COMPOSITE-WOUND 3-PHASE GENERATOR

Alternating-Current Generators, May 1, page 466; Transformers, Nov. 1, page 1076; Transformer Connections, July 15, page 718; Induction Motors, Feb. 15, page 186; Induction Motor Troubles, April 15, page 414; Electric Motor Control, March 1, page 230, and April 1, page 368; Synchronous Motors, June 1, page 574.

A. C. GENERATORS*

Causes that Affect Regulation

By H. P. Hill

WHEN we speak of regulation in an alternator, we mean the percentage of full load voltage by which the pressure rises from full load to no load with the speed and field current unchanged. When an alternator is to supply current for constant potential lighting or to an induction motor load, very close regulation is necessary.

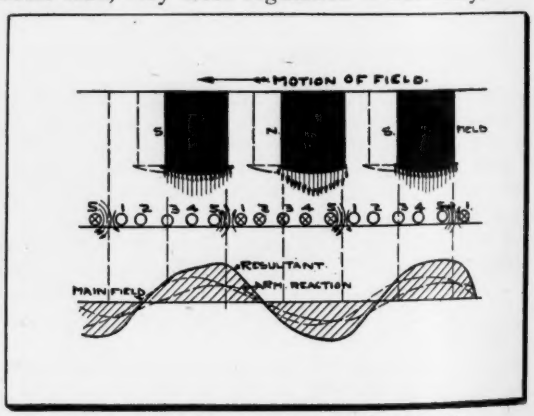


FIG. 2. ACTION WITH LEADING CURRENT

If the load is an electric furnace or a welding machine, close regulation is not essential, and for certain purposes, regulation for constant current rather than constant potential is the aim of the designer.

*Abstract from The Triumph Chronicle.

There are 3 causes which produce the voltage drop in an alternating-current generator under load. The first is due to ohmic and reactive drops, and may be reduced to a minimum by working the iron to the greatest practical magnetic densities, thereby permitting the shortest possible length and number of turns in the armature coils.

The second cause of voltage drop is a result of the partial demagnetization of the fields when the

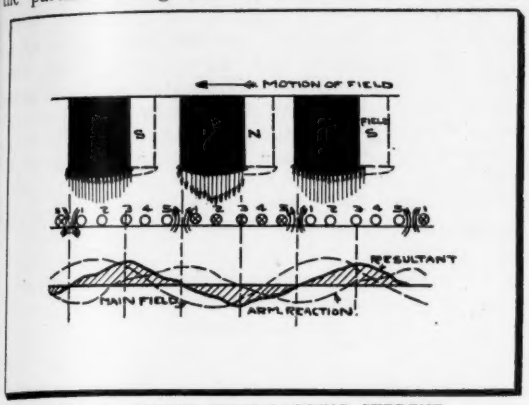


FIG. 3. ACTION WITH LAGGING CURRENT

armature is delivering lagging currents. Figs. 1, 2 and 3 show how the phase position of the armature affects the resultant field.

When the power factor is unity, there is little change in the field strength, although there is distortion with increased saturation in the trailing pole tips. With a leading current the field is strengthened, while with a lagging current weakens the field. It will be noted that the reverse is the case with synchronous motors and rotary converters.

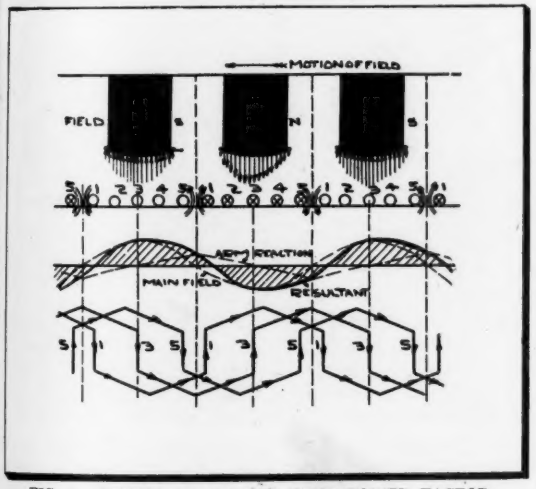


FIG. 1. ACTION AT 100 PER CENT POWER FACTOR

In modern machines the fields are wound with the greatest possible number of ampere-turns consistent with high efficiency, and the armature conductors per pair of poles is limited to such a value as to minimize the effect of the reaction of currents at a low power factor.

The third factor influencing the regulation is speed. An alternator is generally assumed to be driven at a constant speed, regardless of the load. This is seldom the case, however, although it is closely approached in the very latest stations where many machines are operated in parallel. The isolated generator, on the other hand, especially if of the belted type, may be allowed so to drop off in speed as to spoil an otherwise excellent regulation.

CARE AND OPERATION OF COMMUTATORS*

Outline of Some of the Difficulties Encountered in Commutating Machines with Suggestions for Their Remedy

By W. A. Dick

WITH the somewhat complicated construction necessarily involved in commutators and with the very best design, workmanship and material obtainable, there are certain factors which may affect their performance under various operating conditions, the discussion of which will doubtless be of assistance to operators. For convenience the subject will be considered from the standpoints of mechanical, electrical and operating conditions.

Displaced Bars

WHAT may be called a "seasoning out" process may take place, due to the centrifugal forces acting on the bars during operation, which causes a slight displacement of some of the bars and results in a gradual reseating on the insulation. This displacement is more apt to develop in commutators operated at the higher speeds and in large commutators with their greater number of parts. All commutators are seasoned out during the process of manufacture and test, to get the yield out of the materials. so that there will be no displacement of the bars later. Much of this is done, before the armatures are completely assembled, by the application of heat and the tightening up of the bolts holding the parts together. The commutators are not, however, subjected to both heat and centrifugal strains until put into operation, when further seasoning may take place. This is often so gradual as to continue for a considerable period of time, especially on machines of large size. In all such cases the commutators should be tightened if loose and trued up from time to time until a permanent condition is reached.

Eccentric Conditions

COMMUTATORS may run out of true due to bent shafts, spring in shafts from engine thrust or looseness in the bearings. The remedies are obvious. If the eccentricity cannot be overcome by remedying these defects, turning off or grinding at normal speed should be resorted to. Commutators of engine-type machines which have been machined while mounted on test shafts often run slightly out of true when pressed on the engine shaft and require turning or grinding after erection. Electrical machines require shafts stiff enough to take care not only of the mechanical strains but of the magnetic pull set up by the field magnets.

Commutators if subjected to excessive temperatures from overload or defective operation may become distorted and run out of true; this is an abnormal condition and means should be found of reducing the temperatures. This heating can be caused by sparking at the brushes or excessive friction. Friction is least when commutators run true and have a high polish or glaze and the brush faces are polished.

*Abstract from The Electric Journal.

Mechanical vibration may be set up in armatures, and is most apt to be evident on machines operated at the higher speeds, such as turbine-driven units, motor-generator sets, etc. It is usually due to a mechanically unbalanced condition of the rotors. Proper contact between the brushes and the commutator is difficult under these conditions. It should be overcome by rebalancing. Most modern machines are provided with means for balancing either by balancing weights or pockets into which melted lead can be poured; when such means are not provided, weights may be bolted to the rotors, care being taken to place and fasten them so that they cannot get loose. In extreme cases the commutators may be loose on the clamping rings, in which case tightening up of the bolts holding the parts together is required, and turning or grinding may then be necessary.

High Mica

THE mica between the commutator bars may not wear quite as fast as the copper, so that the mica segments eventually project above the copper. This condition is most apt to appear in commutators having a relatively large number of bars which are therefore comparatively thin; it is evident that in such designs the percentage of mica is high as compared to the copper. The amount that this mica extends above the copper may be very slight and still be enough to prevent full and complete contact of the brushes with the copper bars. High mica can usually be detected by mechanical inspection. Results of this condition are likely to appear as fine sparks between the faces of the brushes and the commutator, and also the copper is blackened and burned. The best obtainable grades of soft commercial mica used for insulation are known to vary somewhat in hardness of the built-up segments. A more frequent cause of high mica is believed to be found in the increasing use of softer grades of carbon brushes such as have recently been developed which have less abrasive material in their composition to meet better other conditions of commutation.

Undercutting

THERE is an increasing tendency on the part of both operating and manufacturing companies to resort to the cutting down of the mica between the bars as a means of eliminating any possibility of trouble due to high mica. In some classes of machines, such as single-phase commutator type motors, turbo-generators and special applications, this undercutting is necessary. The undercutting results in better brush contact, eliminates burning due to high mica, improves commutation, thus increasing the life of commutator and brushes, and may reduce the temperature and increase the capacity of machines not limited by temperature rise of other parts. Its general effect is to improve operation. It should be noted that sometimes undercutting may involve a change in the grade of brush to be used to secure best results.

The undercutting may be done by a tool equipped with a thin saw or milling cutter driven by an electric or air motor or a hack saw blade with a backing for stiffening and holding, makes a satisfactory hand tool. A hand chisel may also be used with a straight edge for a guide. The surface of the copper forming the sides of the slots should be left smooth, and at the sharp edges the bars should be slightly rounded. A saw about one inch in diameter, having 30 to 40 teeth and run at a speed of about 2000 r.p.m., meets the average conditions satisfactorily. With very hard mica a saw with a greater number of teeth will cut a little better. A thickness of saw about 0.003 inch less than the width of the slot to be cut will give the right width as the teeth usually have a slight set.

Usually the undercutting must be repeated after the machines have been in service for some time, but is required at only very infrequent intervals. The usual depth of undercutting is one-thirty-second inch and should not be over one-sixteenth inch. The slot should not be less than one-thirty-second inch in width. The objection to a narrow or deep slot is the increased liability of accumulation of dirt and consequently greater difficulty in keeping the commutator clean. The only trouble that can result from the cutting down of the mica is an accumulation of material in the slots, which of itself, or by holding carbon or copper dust, forms a circuit between adjacent bars. The centrifugal forces of the machines on which undercutting is commonly done are sufficient to throw out ordinary accumulation of dirt. A small amount of care and attention and, if necessary, cleaning, will suffice to prevent any dirt accumulation. It is accordingly advisable to make slot inspection and cleaning a part of the regular care of the machine.

Local Roughness

SOMETIMES a sudden and very heavy overload, such as a short-circuit on the line, will cause the current to "bite" into the copper at certain points and leave a condition of roughness. If this roughness is slight, it may wear away with continued operation of the machine. If severe, it may not do so, but may become worse and spread around the commutator. The remedy is to have the commutator smoothed up as soon as possible by working the spots down with a fine file or by means of sandpaper. A flash-over will sometimes make a flat spot on a commutator which will need to be taken out to prevent burning.

With results somewhat similar to those referred to in the previous paragraph, but at a much slower rate, roughness may come on commutators operating on a periodically varying load, as with a gear or other drive such that the maximum load comes repeatedly at the same point in the revolution of the armature.

Such combinations are found in motors geared to reciprocating pumps, air compressors and the like. Thus one part of the commutator is continually worked harder than the rest. This may result in slight burning at this point and, if not watched and kept in good condition, it may extend itself around the commutator. The gear ratio may, however, be modified so as to avoid this. A flywheel is sometimes used to smooth out the peaks and thus keep the current more nearly constant.

In a somewhat similar way, anything that causes poor contact at one point on the commutator throws current to the other brushes of the same polarity, thereby causing them to be overloaded. This may result in burning of the commutator under the overloaded brushes at the time of overload, or it may burn away the brushes or both. The burning may extend around the entire commutator if the cause of the trouble is not removed. Such a condition will manifest itself, at first, in markings on a few bars, usually at a number of points equal to the number of pairs of poles. An illustration of this is the case of a generator driven by an engine in which a lateral movement of the armature takes place coincident with the crank effort.

Cases have been known where a bad splice in a belt has caused a local burning. Some forms of brush holders lend themselves to this, for example, where the area of contact of the brush is changed in case of eccentric action of a commutator. Brushes may become overloaded due to part of the set becoming clogged in the holders so that they do not make contact with the commutator. This overloads the rest so that they gradually burn. Unequal brush tension may also give an unequal loading of the brushes. Some of the shunt connections between the brushes and brush holders may make poor contact either with the brush or with the holder, and throw an excess of current to the other brushes. The remedies in these cases are obvious.

An overloaded brush may be detected by sparking; by glowing, in which spots are heated to incandescence; by honeycombing, in which spots in the face of the brushes appear to be eaten out, or by picking up of copper, where copper appears to be deposited electrolytically in spots on the face of the brush. Honeycombing often starts at these spots of copper due to localizing of the currents. Brushes may be overloaded not only by the external currents, but also by local currents passing between different brush arms due to wrong brush position or too high voltage across the brush. A change in grade of brush will sometimes improve operation where other things fail. Where a brush glows, a softer brush of higher conductivity may often be applied with good results.

STEEL BELTS

Data as to Power Transmitted, Tension Used and Details of Applying—Steel Belts for Power Transmission

By Francis G. Wickware

ATTENTION has been drawn in the pages of Practical Engineer to the growing popularity of the Eloesser steel belts in German power plants. Pulleys designed for rope transmission are being converted to steel belts by shrinking steel band rims over the grooves; transmissions of upwards of 10,000 horsepower have been so converted, with an increase in power of about 10 per cent. Gears also are being replaced, since steel belts are especially

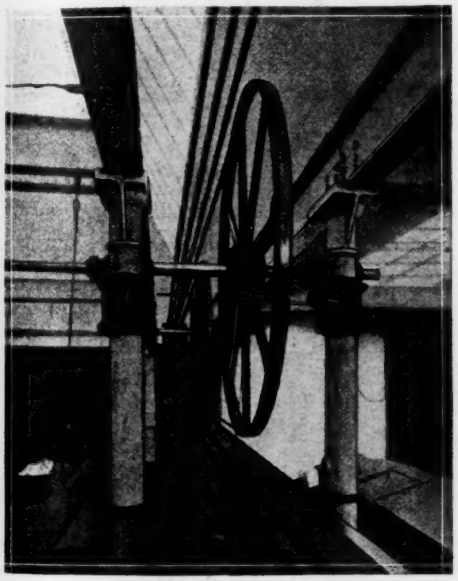


FIG. 2. TEXTILE MILL INSTALLATION WITH 6 1.26-IN. STEEL BELTS ON 5.6-FT. PULLEYS, TRANSMITTING 8 HP. EACH AT 128 R. P. M.

adapted to very short transmissions. The small width of the band facilitates their use in multiple transmissions, particularly as they can be crossed without inconvenience provided the point of crossing is not nearer the pulley than about 70 times the width of the belt. Their durability is a final point in their favor; properly installed, the useful life of steel belts is about 5 yr.

The steel used in these belts, which has to possess unusual elasticity and flexibility to withstand the constant bending and variation of tension, is described by L. Silberberg in a recent issue of the Zeitschrift des Vereins deutscher Ingenieure, as a charcoal steel carefully tempered and prepared by a secret process, rolled at a red heat and finally worked in the cold into strips 0.008 to 0.036 in. thick and 0.5 to 8 in. wide. The ultimate strength of the steel is about 213,345 lb. per sq. in. The ratio of thickness to width of belt varies between one to 300 and one to 350. The tension in the driving side of the belt is in practice limited to 11,378 lb. per sq. in.

Steel belts are especially applicable to the transmission of large powers with large pulleys revolving at a rate of not more than 900 r.p.m. The slightest eccentricity of one of the pulleys sets up excessive

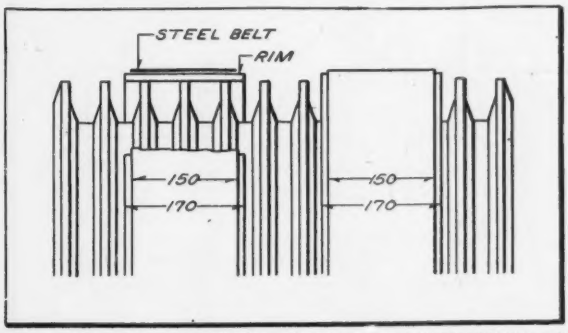


FIG. 1. METHOD OF CONVERTING ROPE TRANSMISSIONS FOR STEEL BELTS

stresses in the belt. An eccentricity of 0.04 in., for example, in a transmission with 15-ft. centers and with a belt 39 ft. long increases the tension in the belt by 9,956 lb. per sq. in. and has a serious effect on its safety.

In general, pulleys should be spaced, center to center, at least ¼ of the belt travel per second. Where it is impossible to observe this rule, the thickness of the belt must be increased, or, if the pulley is too small to carry a thicker belt, the belt should be doubled or tripled.

The fastener used for steel belts consists of 2 steel plates, tangent to the pulley to which the ends of the belts, at the desired tension, are fixed by short screws. The screws are thus securely soldered at a low temperature. The fastener is illustrated in the

accompanying figures. Width for width, steel belts are capable of transmitting 3 to 5 times the power of leather belts; the possibility of using with them narrow and economical pulleys is one of their strongest recommendations.

TABLE I. TESTS OF COEFFICIENT OF FRICTION BETWEEN STEEL BELTS AND CORK COVERED PULLEYS

INITIAL PRESSURE LB. PER SQ.INCH.	BELT SPEED FT. PER MINUTE	USEFUL TENSION LB. PER SQ.INCH	COEFFICIENT OF FRICTION	HORSE-POWER TRANSMITTED
14,508	3006	10,667	0.27	16.8
14,223	5826	16,072	0.36	42.5
14,223	6000	16,356	0.39	44.8
14,508	3090	18,632	0.45	26.3
15,645	2992	19,628	0.45	26.5
22,899	3031	20,481	0.30	28.5
22,188	5964	21,050	0.32	77.2
22,046	6930	25,175	0.44	80.3
21,335	3858	25,175	0.425	44.7
21,335	5807	28,446	0.52	76.0
21,335	2696	35,273	0.75	44.0

To increase adhesion, the rims of the pulleys are covered with sail cloth and a thin layer of cork. The accompanying table shows the slight variation in the coefficient of friction between steel belts and this surface, and its increase with the effective tension.

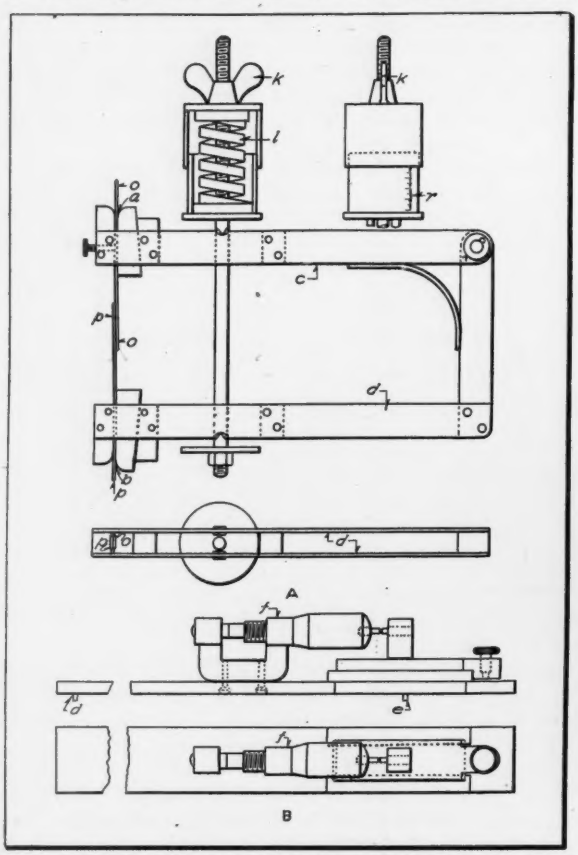


FIG. 5. (A) METHOD OF APPLYING TENSION AND (B) MEASURING STRETCH OF MEASURING TAPE TO GET PROPER BELT LENGTH

With pulleys 5 ft. in diameter, the slip in these tests did not exceed 0.1 per cent; it rose to 0.3 per cent when one pulley 23¾ in. in diameter was substituted. For an effective tension of 10,000 to 11,000 lb. per sq. in. the coefficient of friction is about 0.27 on cork-covered pulleys, practically the same as the coefficient between leather belts and cast-iron rims.

For transmissions subjected to great variations of temperature, the initial or static tension in the belt should not exceed 3 times its driving power. The contractions at low temperatures have little effect in increasing the stress.

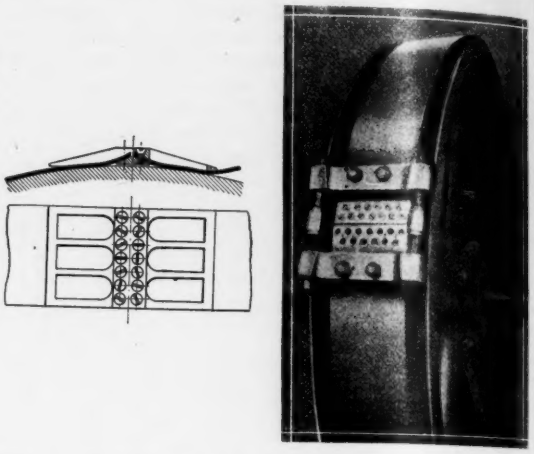


FIG. 3. FASTENING FOR STEEL BELTS AND METHOD OF APPLYING TENSION

One of the most important points in the installation of steel belts is the accurate determination of the length of belt required to give the desired tension. For this purpose a thin steel band 0.008 in. thick and 0.2 in. wide is stretched over the pulleys and subjected to the desired tension. The apparatus employed is illustrated in the accompanying figures. The ends of the band are secured at a and b at the ends of the arms c and d. Tension is applied by the spring l, adjusted by the screws k and measured on the scale r. In the unstretched band two small holes are drilled exactly

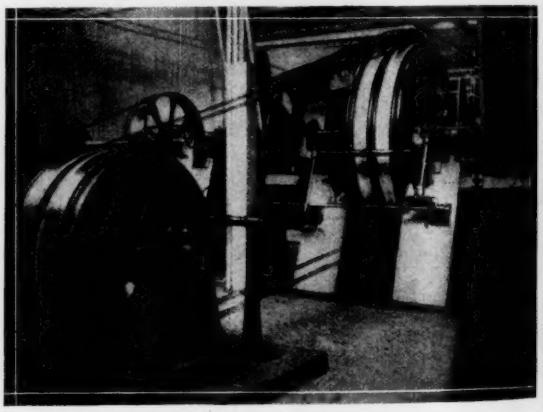


FIG. 4. THREE STEEL BELTS 5.9 IN. WIDE ON PULLEYS 6.7 IN. WIDE, REPLACE 11 ROPES AND TRANSMIT 350 HP. PULLEYS 53.15 IN. DIAM. AT 360 R.P.M. AND 94.28 IN. AT 200 R.P.M. ON 18 FT. 8 IN. CENTERS

3.28 ft. apart. After the proper tension is applied the lugs d and e of the comparator shown in the lower figure are fitted into these holes. The number of turns of the screw f required to return the comparator to zero setting gives the extension of the band in 3.28 ft. and from this the proper belt length is easily calculated.

SPECIAL SLIDE RULE

Rule With a Special Scale to Simplify Operations Necessary to Find the M. E. P. of a Steam Engine

By R. M. Fotheringham

IN the article by Richard Howarth, "Every Day Calculations" in Practical Engineer for February 15, he shows the method of calculating by the slide rule, the horsepower from the indicator diagram: he says "according to the planimeter the m e. p. is 65 lb. per sq. in." and then proceeds to make the calculation.

But suppose there is no indicator diagram of the engine and all the information we have is that the cutoff occurs at ¼ stroke, that the steam pressure is 100 lb. by gage and that the engine is noncondensing, then how are we to determine the m. e. p.?

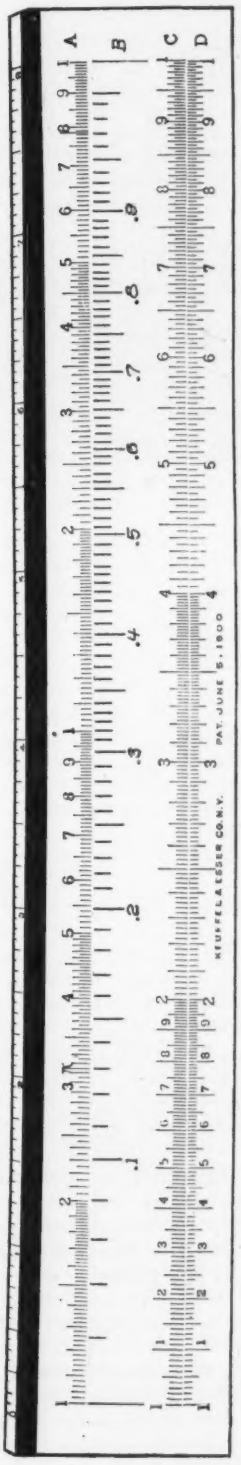
Well, we find the ratio between the theoretical m.e.p. (p^m) and the initial absolute pressure (p^1) by the formula $\frac{p^m}{p^1} = \frac{17 - 16r^{-\frac{1}{16}}}{r}$, then having found that ratio we multiply it by the initial absolute pressure which in this case is 115 lb., then deduct the back pressure: in this case say 16 lb. absolute or 1 lb. above atmosphere, then multiply the result by the factor of efficiency for the class of engine and the product will be the actual m. e p.

This is all very good but rather laborious and I wish to submit an ordinary slide rule with the upper scale on the slide substituted temporarily by another scale to enable us to find the theoretical ratio $\frac{p^m}{p^1}$ for any cutoff at one operation. If the engine is compound, triple or quadruple expansion we want to know the m. e. p. referred to the low-pressure cylinder and if we have given the point of cutoff in the high-pressure cylinder we can find the theoretical ratio $\frac{p^m}{p^1}$ referred to the low-pressure cylinder by one operation of the slide.

This scale was constructed by the writer by a kind of process of evolution based on the formula

$$\frac{p^m}{p^1} = \frac{17 - 16r^{-\frac{1}{16}}}{r}$$

and it has been used by him for many years and can be confidently recommended as a great time-saver especially when one wants to ascertain what power a given engine should develop under varying conditions of cutoff or conversely, where the cutoff will occur under different loads, for, of course, the processes can all be reversed. Having found the ratio $\frac{p^m}{p^1}$ the other operations consist simply of multiplying and subtracting and present no difficulty. Factors of efficiency for various types of engines are given by Seaton and are quoted in Kent's handbook. This factor provides for the losses due to clearance and compression and other losses which it is impossible to compute exactly; it is derived from experience and the engineer who has the opportunity of studying indicator cards from different engines can readily make comparison between the actual m.e.p. shown by the indicator diagram and that computed by the above method and determine for himself factors to be used for engines of various types; he can also compare engines of the same type and see if one is showing a higher efficiency than another and, if so, then it is desirable to find out the reason, as the inefficiency may be due to leakage of valves or some cause which could be removed.



FINDING THE RATIO BETWEEN THEORETICAL M. E. P. AND THE INITIAL ABSOLUTE PRESSURE BY MEANS OF SPECIAL SCALE SLIDE RULE

We will now deal with some examples:

Example 1. The engine referred to above: Simple engine, noncondensing, steam 100 lb. by gage, 115 lb. absolute, back pressure 16 lb. absolute, cutoff at 25

per cent of stroke. As this is a simple engine it is not necessary to move the slide on the rule, but under 25, the point of cutoff on right hand A scale find the ratio $\frac{p^m}{p^1} = 0.58$ on B.

Then $0.58 \times 115 = \ldots\ldots 66.7$
Deduct back pressure $= \ldots\ldots 16$

50.7

Multiply by factor of efficiency:
If the engine is a high class Corliss the factor may be taken as $= \ldots\ldots 0.94$

$50.7 \times 0.94 = 47.658 = \ldots\ldots$ m.e.p.

Example 2. A compound condensing engine; cylinders, h-p. 20 in., l-p. 40 in., steam pressure 120 lb. by gage, 135 lb. absolute; back pressure in l.-p. cylinder 2.5 lb. absolute; cutoff in h-p. cylinder at 30 per cent of stroke.

Move the slide till 20 on C is over 40 on D. Now, under 30 (the cutoff) on A, read 0.254, the ratio $\frac{p^m}{p^1}$ on B.

Then $0.254 \times 135 = \ldots\ldots 34.29$
Deduct back pressure $= \ldots\ldots 2.5$

31.79
Multiply by factor of efficiency, say $= \ldots\ldots 0.9$
$31.79 \times 0.9 = 28.611 = \ldots\ldots$ m.e.p.

Example 3. A triple expansion condensing engine; cylinders, h-p. 20, i-p. 36 and l-p. 58 in.; cutoff in h-p. cylinder at 27 per cent of stroke; steam pressure 150 lb. by gage, 165 lb. absolute; back pressure in l-p. cylinder 2.5 lb. absolute. Move the slide till 20 on C is over 58 on D, then under 27 (the cutoff) on A read 0.132. the ratio $\frac{p^m}{p^1}$ on B.

Then $0.132 \times 165 = \ldots\ldots 21.78$
Deduct back pressure $= \ldots\ldots 2.5$

19.28
Multiply by factor of efficiency, say $= \ldots\ldots 0.92$
$19.28 \times 0.92 = 17.73 = \ldots\ldots$ m.e.p.

These examples will show how easily by the use of this special scale on the slide rule, the m.e.p. of any steam engine may be determined.

As a protest against what is considered by the officials and business men of Ballston Spa, N. Y., as an injustice on the part of the Adirondack Power corporation, a public meeting was held at the court house to talk over the question of street lighting and the advisability of the establishment of a municipal lighting plant. This village since 1906 has had its streets lighted at a rate of $15 a lamp of 21 candle power, all night system. The company now proposes to raise the rate to $21 a year, a rate in force for lamps before the price was lowered. While the question of a municipal lighting plant was favored by many, all agreed that the village should move carefully and that the trustees should have further conference with the officials of the company and endeavor to obtain a fair rate, in the event of this not being successful then that steps be taken to have the municipality furnish light, not only for its streets, but to private consumers.

HEAT TRANSMISSION THROUGH CORRUGATED IRON

Modern tendency to construct shops and manufacturing establishments with large window areas, the concrete or steel frame often forming little more than a grid for the windows, has directed much attention to the calculation of the heating requirements of such buildings.

The Green Fuel Economizer Co., of Matteawan, N. Y., which has installed hot-blast heating equipments for a considerable number of concrete and glass buildings and also for buildings covered with sheet metal, recently had an opportunity to ascertain the transmission through a building of this kind, the structure being a shop for the manufacture of fans and blowers erected by this company some time ago.

The shop measures 225 ft. long by 48 ft. wide, with an average height of 32 ft. There are continuous windows on one side 15 ft. high and on the opposite side, 19 ft. high. Otherwise, the building is covered with corrugated iron of single thickness without lining. The crevices at the eaves are filled with asbestos and the corrugated iron is cemented in at the bottom, and other measures have been taken to make the building as air tight as possible. The exposure of the windows is east and west, the smaller windows being on the east side.

The coefficients given by different authors for the rate of heat transmission through single windows vary somewhat. Prof. Homer Woodbridge gives for single windows with a southern exposure, a coefficient of 1 B.t.u. per square foot per hour per degree difference in temperature between inside and outside. For northern exposure he suggests adding 35 per cent, for eastern exposure 15 per cent, and for western exposure 25 per cent. Ludwig Dietz, quoting Dr. Rietschel, of Berlin, and also the specifications of the Prussian Government, gives for single windows 1.026, and Dr. Rietschel suggests increasing this 10 per cent for northern exposure or north-easterly or north-westerly exposures, and 10 per cent for especially strong winds.

The only figure for corrugated iron without sheathing that has been found, is one by Rietschel, of 2.132, but without any statement as to whether this refers to superficial wall area or to the actual surface of the iron.

Calculating from the data and rules of Grashof and Rietschel, the transmission per square foot per hour per degree temperature difference for a single window, works out as 0.958, and for a single thickness of sheet metal as 0.955, practically the same.

This, however, is not taking account of the additional surface of the sheet metal wall due to the corrugations. The corrugated metal used in the building under discussion, has one corrugation to every 2½ in., the depth of the corrugation being 1 inch. The actual surface of the metal is approximately 1.35 times the superficial area. This would make the rate of heat transmission for corrugated sheet iron, figured on the basis of superficial area, approximately 1.35 times 0.955, or 1.29.

The values obtained by Grashof's method for both glass and sheet iron are thus seen to be lower than the values used in ordinary practice. This may possibly be explained on the hypothesis that the constants used in ordinary practice have been increased to account for losses due to leakage, the opening and shutting of doors, etc. Weight is lent to this view by the results of the tests which follow, bearing in mind

that the construction of the present building makes it practically air tight. At the same time, the values obtained were slightly greater than Grashof's formula would call for. Any close agreement is, of course, not to be expected, as the sheet-metal-working machinery and shafting housed in the building were in constant operation during the test, producing heat which was not measured, while on the other hand, doors were being opened for the passage of men and materials on an average of once every 10 min.

The total surface of the building is made up of approximately 7538 sq. ft. of window, including the sash, 8247 sq. ft. of wall surface and 11,925 sq. ft. of roof, the walls and the roof being given in superficial area. The total of wall and roof areas is 20,172, which, increased by the factor 1.35 to account for the corrugations, gives 27,130 sq. ft. total metal surface. The total superficial expanse of the building is 27,710 sq. ft., and the total actual surface, counting the metal in the corrugations, is 34,658 sq. ft.

The building is heated by a Green's hot-blast heater, consisting of an engine-driven centrifugal fan, drawing through a Positiv-flo heater made up of 6 sections of 4 rows of pipe each, the sections measuring 7 by 8 ft. The heater is ordinarily drained of condensate and air by a Dexter vacuum system. There are altogether 6816 lineal feet of 1-in. pipe in the heater, or 2272 sq. ft. of heating surface. The air is distributed throughout the shop by circular sheet iron conduits with outlets directed down into the one occupied by the workmen, as shown in the accompanying drawing.

The fan and heater had been running for about 2 hr. when the first readings were taken at 8:30 a. m., and the temperature of the shop was maintained constant until readings were discontinued at 11:30 a. m.

During the test the fan was run at 258 r.p.m., receiving 22,416 cu. ft. of air per minute, figured to 50 deg. F., the air actually being received by the heater at 73 deg. F., and delivered from the fan at

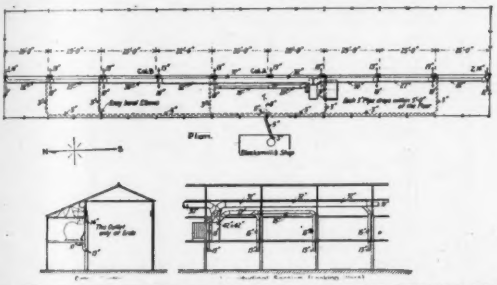


FIG. 2. PLAN AND SECTIONS OF BUILDING UPON WHICH TESTS WERE MADE

156 deg. F. The temperature of the steam in the heater was 212 deg. F. The temperature of the air delivered from the farthest outlet was found to be 141½ deg. F Under these conditions, the temperature of the building, measured 3 ft. from the floor, was 66 deg., and measured in the gallery, 70 deg., the temperature out of doors being 15 deg. F.

For the determination of the total heat, 2 methods were employed. First it was calculated from the amount and rise in the temperature of the air passed through the heater, and secondly, from the condensation in the heater. For the latter purpose, the steam pipe from which the steam was introduced to the heater was carefully drained and the condensate from the heater was weighed. Figured by the air method, the consumption of heat was 2,084,000 B.t.u. per hour, and by the condensate method, 2,029,730 B.t.u. per hour.

Using the air figures, we find that the average rate of heat transmission through the superficial area of the building, that is not counting the corrugations, was 1.42 B.t.u. per sq. ft. per hour per degree difference, and using the steam value, 1.38 B.t.u.

If we take Prof. Woodbridge's figures for the rate of heat transmission through the windows, we would have for a window on southern exposure, 1 B.t.u. per square foot per hour per degree difference, which, however, is to be increased 15 per cent for eastern exposure and 25 per cent for western exposure, or in the present case, an average of approximately 20 per cent. Figuring the window surface as 1.2, the value

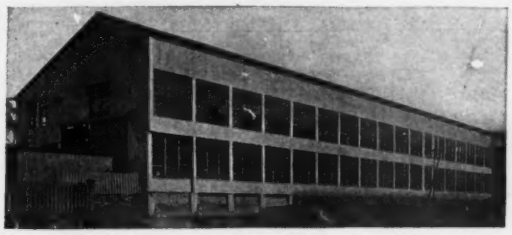


FIG. 1. EXTERIOR OF FAN SHOP COVERED WITH CORRUGATED STEEL SHEATHING

for the corrugated iron, figuring superficial area only, is 1.5, or figuring the whole surface of the iron, 1.13, that is less than an equivalent amount of glass surface. This hardly seems likely, although it may be possible, the explanation in that case being perhaps that the corrugations in the iron protect the surface to a certain extent.

If we take the value obtained by Grashof's method for the glass windows, namely 0.958, the value for the actual iron surface comes out at 1.19, but on the basis of this formula, there would be no reason for expecting any such difference between the iron and the glass.

Allowing for the many undeterminable conditions, it would probably be safe in calculating the heat supply for buildings of this kind, to provide for a coefficient of transmission of 2 B.t.u. for the whole wall and roof area.

The coefficient of transmission through the surface of the hot blast heater in this test was 9.41 B.t.u. per square foot per hour per degree average difference in temperature between the air and the steam, figured by the ordinary arithmetical method in which the average difference in temperature between the steam and the air is assumed to be the difference between the steam temperature and the mean of the air temperature on entering and leaving.

Figured according to the logarithmic formula, which takes account of the fact that the air rises more rapidly in temperature in passing over the first rows of tubes than in passing over the later rows of tubes, the value is 10. The mean physical velocity of the air through the heater was 1210 ft. per minute.

In a subsequent test, with air entering at 72 deg. F. and leaving at 166 deg. F., and steam at 213 deg. F., in which the velocity of the air was 760 ft. per min., a coefficient of transmission of 7.5 (logarithmic) was obtained. 10 and 7.5 are in the ratio of the 0.64 powers of the respective velocities, that is, the coefficient did not vary directly as the velocity, as frequently asserted. If, instead of mean velocity, we use flow in pounds of air per minute through the heater, which amounts to the same thing as velocities reduced to a standard temperature, the coefficients are found to be in the ratio of the 0.62 powers of the rates of flow.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

The Voorhees Refrigeration Process*

By J. H. Blakey

THE Voorhees system of refrigeration by multiple compression, gives a considerable economy of motor power in the production of freezing temperatures, and has besides the advantage that it may be applied at small expense to existing carbonic acid machines.

The economy of power may be put at a minimum of 20 per cent, but may in some cases reach as high as 50 per cent, according to the conditions of application.

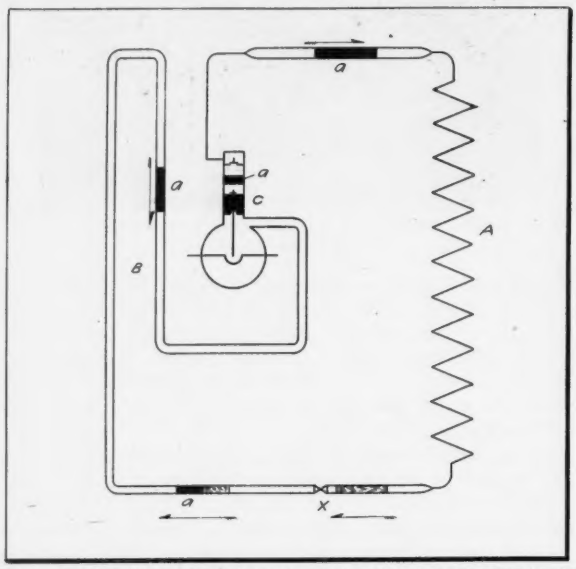


FIG. 1. DIAGRAM ILLUSTRATING THE COMMON REFRIGERATION PROCESS

The additions to be made to the parts of an ordinary refrigerating machine are: 1. A receiver which separates the gas from the liquid after having passed the first expansion valve. 2. A second expansion valve, automatic, in connection with the receiver. 3. A controlled valve for the passage of the receiver gas in the compressor at the end of the aspiration, in order to produce multiple compression. 4. A hose connecting the receiver with the compressor.

It is with carbonic acid machines that the greatest advantage is obtained.

Figure 1 shows an ordinary carbonic acid refrigerating machine, composed of a condenser A, for refrigerator B and a composer. A quantity of carbonic acid corresponding to the weight of the gas displaced by a single stroke of the compressor is shown at a, a, a. This quantity after having passed the valve X becomes half gas and half liquid, for the reason that the gas is cooled by its own vaporization at a temperature and pressure inferior to those of the refrigerator B. In consequence of its reaching the refrigerator the half only of the carbonic acid remains liquid, and in a condition to produce a useful effect. On leaving the refrigerator the carbonic acid is in practice completely gaseous, and is thus aspired, then compressed by the compressor.

Figure 2 shows the working of the Voorhees system. The only addition is the receiver E, the connecting tube to the compressor and the second expansion valve Y. In this case 2 portions of carbonic acid are shown at a and b, leaving the condenser, each one equivalent to the weight of the gas drawn from the refrigerator into the compressor by a single stroke, as in Fig. 1. In passing the first valve X, half of the carbonic acid is vaporized as shown at b while a remains liquid, a and b entering into the receiver at a pressure double that of the refrigerator; the portion a finally reaches the receiver after passing through the refrigerator.

At the end of the aspiration stroke the hose connecting C and E opens and allows the admission of the portion b at a pressure double that of a, which it immediately compresses to its own pressure. By the compression stroke a and b are driven back into the condenser, and the action continues as before.

In these conditions the refrigeration at B with the Voorhees system (Fig. 2.) is almost double that obtained by the ordinary system (Fig. 1.) even though the compressor remains the same. A smaller advantage is obtained when the water of condensation is very cold.

The principle of the multiple effect compressor is that the compressor aspires the gas at different pressures, one after the other, during the aspiration stroke; the gas of highest pressure producing a compression on those which have preceded it, and thus economizing a large part of the motor force which was necessary

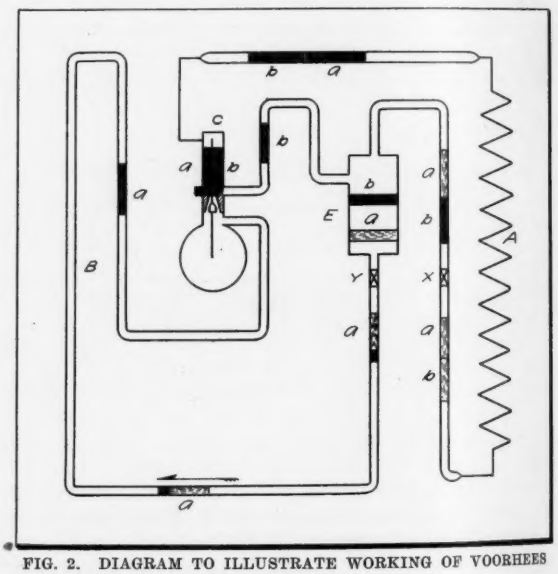


FIG. 2. DIAGRAM TO ILLUSTRATE WORKING OF VOORHEES SYSTEM

without this arrangement. At the same time the power of refrigeration is increased, because there is an addition to the weight of gas aspired at each stroke of the compressor piston.

The principle of the receiver consists in the fact that when a liquid at a given temperature passes a regulable orifice which lowers the pressure, a part of the liquid is vaporized in order to lower its temperature to that which corresponds to this lower pressure.

*From Le Revue Industrielle, Sept. 7, 1912.

In all liquefied gas refrigerating machines this effect is produced. The quantity of gas vaporized at the expansion orifice depends also on the properties of the refrigerating gas employed. This quantity is greater or smaller according to the difference of temperature on the 2 sides of the orifice. Because of the very small latent heat of carbonic acid, the quantity vaporized at the regulating cock is enormous. As the gas produced at this point has no need of being aspired by the compressor, the compressor can act on a larger quantity of the gas formed in the refrigerator and give thus a stronger refrigeration.

The multiple effect separator or receiver of Fig. 2 is provided at X with a first expansion valve, and at Y with a second, this latter being actuated automatically by a floater in the liquid of the receiver E. This arrangement does not present any difficulty, as the quantity which escapes from the receiver corresponds exactly to that which flows in.

The multiple effect compressor allows the lowering of the temperatures at the condenser, and reduces the effect of detrimental spaces, at the same time that it increases the volumetric efficiency, which can be still further raised by employing water at 88 deg. F. in place of the waters of condensation at 86 deg. F.

Another advantage of the Voorhees system is that the machine to which this complementary apparatus has been added, can be worked exactly as before, nothing having been changed in the condenser, the pumps or the refrigerator.

AN ABSORPTION MACHINE TRICK

How Jerry Made a Good Showing at the Expense of His Co-worker

By Walter C. Edge

WHAT'S the matter with you anyway, Ed? For some time past you've been losing several points in the brine your first hour, although you gain about ½ deg. an hour for the balance of the day. Are you sleepy your first hour, or what ails you?"

"No, Jim. It's got me rattled. Come in about 6, sign Jerry's report after looking at the brine temperature, and by the time I've got my working togs on, the temperature is back 2½ deg., then she gains ½ deg. by 7 o'clock; but it's about 11 before I get her where she was when Jerry left."

"You don't know what makes her go back do you?"

"No, but it's funny that Jerry can gain 3 deg. his last hour, when the best he can do all night is ½ deg. per hour."

"His report for last night shows only ½ deg. gain his last hour, Ed, but he gained 8½ deg. in all while you only made 3½."

"Something rotten! Jim."

"The Watchman told me he gained 3 deg. his last hour every day."

"Well, if this is true, I think I can see how it occurs. I'll look into it, Ed."

About 5 a.m. the next morning, Jim stole into the engine room unnoticed and secreted himself so as to have a view of everything. About 5:45, Jerry went to the boiler room, and Jim took a reading of the thermometer, showing 6 deg. below zero, quickly retiring to his hiding place. In a few minutes Jerry came in, and looking at the clock, the hands of which showed the time to be 10 min. to 6, he went direct to the cooler, and shut the expansion valve tight. At 5 minutes before 6 he took a position in the doorway, looking down the street, presumably to catch sight of Ed. Just about 15 seconds before Ed arrived, Jerry ran to the cooler and opened the expansion valve to its original position.

Ed walked in, putting his hat in the closet, and then went to the machine with Jerry; looking at the thermometer he signed Jerry's report.

"Well, so long, Ed."

"Good bye, Jerry," and Jerry disappeared out the door.

"Well, Ed, I've got the trouble," said Jim as he stepped from his hiding place, causing Ed to jump by his sudden appearance.

"What did the thermometer say a few minutes ago, when you signed Jerry's report?"

"Eight and a half below," said Ed.

"Look at it now and see what it is."

"Eight!" exclaimed Ed; "back ½ deg. already."

"Yes, and it will go back to 6 inside of 5 minutes. At 10 minutes to 6 Jerry shut the expansion valve, opening it again a few seconds before you arrived, causing the cooler to take several more points out of the brine passing through, caused by less pressure in the cooler, allowing the ammonia to expand more."

"Why don't it stay down then, Jim?"

"Simply because the main body of brine was not lowered in temperature, but just that small quantity passing through at that time. You see Jerry discovered that with a certain pressure on the cooler, the expansion valve could be closed, and kept so for 10 minutes before losing ground. So this is the way he has been robbing you of 2½ deg. in temperature for some time."

"How are you going to get him to cut it out, Jim?"

"Well, I'll buy a recording thermometer and take the reading from the tank direct, which will knock this trick in the head."

Plans are under way for a meeting of the American Society of Mechanical Engineers with the German Engineering Society next June, a representative of the German Society having recently paid a visit to the United States to arrange for the professional papers, inspection trips, etc. The party will leave this country on June 11, and arrive in Germany on June 21, 1913. Visits will be paid to the great shipyards, and a special train will take the party to Leipzig where a gathering will be held to promote acquaintance. At the formal opening on June 23, the Society will be welcomed by the King of Saxony and the municipal authorities of Leipzig, and a session will be devoted to the Relations between Capital and Labor, and the Effect of Technical Education on Industry. Tuesday will be taken up with technical papers and social events, and on Wednesday the party will leave for a tour of the principal cities of Germany, including Dresden, Berlin, Dusseldorf, Frankfort, Nordenberg, Munich and others. A final meeting will be held in Munch, July 27, at the Museum of Technical Arts. The entire program will occupy the time from June 22 to July 7, divided between technical sessions and discussion of papers, and visits to the German industrial plants and to places of historic and scenic interest.

The Big Cottonwood hydro-electric power plant of the Utah Light & Railway Co. at Salt Lake City is undergoing enlargement of capacity and other general improvement. The horsepower output of the Big Cottonwood plant is being increased by 1000 to accommodate the larger drain upon the generating system of the company through operation of new lines.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

TROUBLE WITH LEBLANC PUMP

THE vacuum dropped suddenly one day from 27½ to 24 in. in the Leblanc condenser of our double flow turbine; as it was a new thing in the station, it kept us guessing for a while; finally it was discovered in the air pump. The blades F, Fig. 2, broke loose from the cast-iron disk K, Fig. 1. It was held in place by ⅜-in. bolts, some of which got loose and

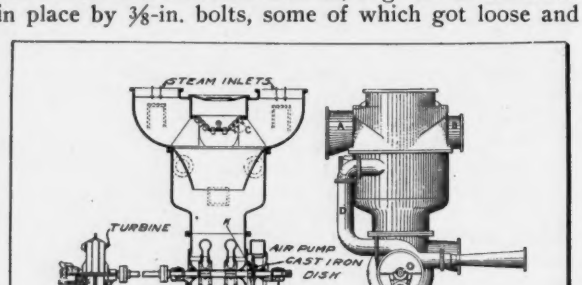


FIG. 1. SECTION AND EXTERIOR OF LEBLANC CONDENSER

fell out, and the rest sheared off. As no further damage was done, new bolts and nuts were put on, and the ends riveted over. The turbine was started and found to be all right.

Figure 1 shows a cross section of the condenser. The connecting pipe between the 2 turbine exhausts is utilized as part of the condenser and contains the atmospheric exhaust A, the injection water connection B, and the water spray nozzles C. The steam entering through the 2 top openings is brought into con-

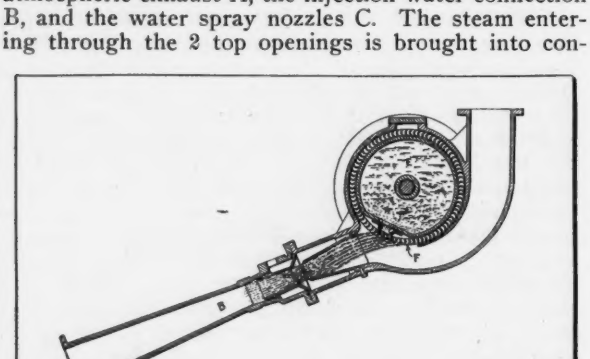


FIG. 2. LEBLANC AIR PUMP

tact with the water issuing from the spray nozzles and is condensed, the mixture of water and condensed steam falling through the large cone into the entrance of the centrifugal pumps which removes it to the hot well.

On the righthand end of the shaft is located the air pump. This is in a separate chamber from the centrifugal pump. The water used in the air pump is taken from the cold well and is discharged back to the same place.

The air is withdrawn from the condenser through pipe D, which is attached at a point where the condensation is complete, so that no live vapor is drawn into the air pump.

Figure 2 represents a section through the air pump. Water enters at E, the revolving annulus of blades F, cutting off the laminae which are thrown downward through the diffuser B, and between these laminae large volumes of air are entrained, making a continuous formation of a succession of water pistons.

Thomas Sheehan.

TESTING ROD PACKING; ENGINE CAPACITY

AMONG the many interesting and instructive articles which appear in the Nov. 1 issue, there are 2 in particular that attracted my attention and upon which I wish to write briefly.

The first is A. C. Waldron's "Testing Rod Packing," page 1090. Mr. Waldron has given us the benefit of his experiments with pump rod packings, and he has shown how much loss may occur by using unsuitable packing, and also by improperly setting up suitable packing.

Few men have the sense of touch sufficiently developed to enable them to adjust rod packing so that it is correct, and so we often see pump rods, and other rods as well, running through packing which is too tightly set up, not only causing a needless waste of power, as shown by Mr. Waldron, but also causing undue wear upon the rod itself.

I believe that, as far as possible and consistent with all considerations, metallic packing should be used in pumps as well as in engines. In some cases it is used, but not generally. Its first cost is looked upon as prohibitive; but a properly fitted metallic packing, of the kind which cannot be tampered with after it is installed, will pay for itself in a reasonable period of time, this is particularly true in places where there are a number of pumps to keep in order, and where a large quantity of packing is consumed.

I am not condemning soft packings in a wholesale manner, for they have their uses, and when employed and handled intelligently are all right. Undoubtedly metallic packing is superior for some things, and I think in many instances it is more suitable for pumps than the fibrous packings. Let us have the opinions and experiences of readers in relation to this matter.

The other article upon which I wish to comment was also written by A. C. Waldron under the heading of "Increasing Engine Capacity," page 1093.

This article naturally suggests the question "When is an engine over loaded?" Likewise "When is an engine under loaded?" This is a matter that many are

not quite sure of, if we may judge from the statements occasionally made in relation to the subject. It seems to me, that when an engine carries a load in excess of that for which it was designed to develop with economy it is over loaded. If the load carried is less than that for which the engine was intended, then it is under loaded.

But, it may be said, that some makes of engines are more economical than others, and therefore you can have no fixed guide as to when an engine is either over or under loaded. An engine may be over loaded, and yet be able to carry more load, but not economically. It is the difference between capacity and economy.

Speaking in general, and not desiring to go into refinements, the terminal pressure in an engine cylinder determines whether an engine is over or under loaded. But the terminal pressure in an ordinary, plain slide-valve engine, when carrying its most economical load, is considerably higher than that of a 4-valve, or automatic cutoff engine.

In the 2 latter, theoretically speaking, the load at which best economy is secured, is that which obtains a terminal pressure just a little in excess of the back pressure. When the load is such that the terminal pressure is considerably above the back pressure, the engine may be said to be over loaded. If the terminal pressure is less than the back pressure, as shown by a loop on an indicator diagram, then the engine is under loaded.

In the ordinary, plain, slide-valve engine, throttling governor, the point of cutoff is fixed but the pressure is increased or decreased, within limits of course, by the action of the governor, this terminal pressure may also be used here to indicate load conditions. For each engine, or class of engines, there is a certain terminal pressure (which is a measure of the steam consumption) at which best economy may be obtained. Once knowing this terminal pressure, any departure from it shows whether the engine is over or under loaded. Here again, is opportunity of discussion.

Charles J. Mason.

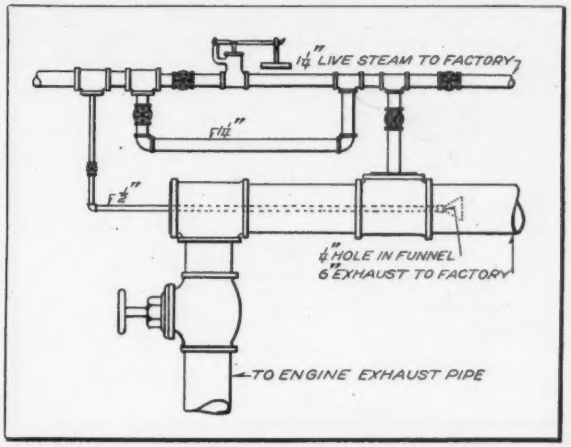
HEATING SYSTEM

I AM more than pleased for the advice given through Practical Engineer regarding the heating system and siphon that I asked advice upon in the June 1 issue. Prior to our fire some of our ware took from 3 to 4 weeks to dry so that they could be burnt. Now with the new system 7 days will do the work. Every winter prior to installing the new system there was a loss to our company of several hundred dollars from frozen ware. Last winter was the coldest we have had in 14 yr., the thermometer went down as low as 20 deg. below zero, and we had no trouble from freezing, and still the system was not complete, there were no air cocks on the heaters nor was the siphon in operation.

Now at this time the system is completed and every thing in good shape, the result is far beyond what the firm expected. I have one steam gage on the exhaust line right close to the engine and one on the extreme end of line about 300 ft. from the first, the siphon is set 20 ft. from the first gage, the relief valve is between the first gage and the siphon.

When the engine is running and everything is in operation the first gage shows a back pressure of 2½ lb. and the second gage shows 5 lb. on the line. Now if things are reversed, that is, shutting off the siphon, the back pressure on the gage will show 3 lb. and the gage on the extreme end will show 3 lb., this shows that when the siphon is in operation the back pressure on the engine is reduced and the pressure on the line is increased.

Now admitting that A. K. is right when he says that steam flowing through ¼-in. pipe to the atmosphere at 50 lb. pressure will use about 115 lb. of water per hour or 3½ hp. per hour, which I know it is not doing because the steam is not blowing to the atmosphere but through a pipe that already has a small pressure, is it not more economical to reduce the back pressure on the engine from 1 to 2 lb. and increase the pressure on the exhaust line than to use



SIPHON OR EJECTOR USED IN HEATING SYSTEM

live steam to get the result needed? I know many of the readers of Practical Engineer will say why don't you install a vacuum pump, I will say I am working for a firm that thinks a dollar a mighty big article so one has to do the best he can under such circumstances.

In order that the readers of Practical Engineer may see just how the siphon is made you will find enclosed a blue print, the cut that has been shown is not right, the small end of funnel is ¼ in. and the large end is 3 in.

P. J. C.

SURFACE CONDENSER INSTALLATION

SET the condenser as close to the engine as you can, have as few bends as possible in your exhaust pipe, and lift your water for cooling purposes as little as you can. It takes steam and costs money to operate your circulating pump, so make a short lift.

If only ½ lb. loss occurs by reason of extra bends in exhaust pipe, that will probably cause you to carry from 3 to 4 lb. higher boiler pressure, and take more fuel and labor.

If pressures render it possible, turn the exhaust from pumps (circulating, air, vacuum or boiler feed pump) into the receiver between the high and low-pressure cylinders. This will result in considerable economy.

H. L. S.

THE WORK OF BUILDING the new plant of the National Cast Iron Pipe Co. at Boyles, Ala., has just begun. The plant will be modern in every way and will be the latest industry built in this city. A. H. Ford is president of the concern ,while other local people are also interested. The company expects to begin manufacturing pipe as soon as the plant is finished.

AREA OF TRIANGLE

IN the September 15 issue of Practical Engineer is an article under the heading Mensuration. Now, I know it to be a fact that the ordinary engineer prefers a rule which is not easy to forget once he has used it. The rule to find the areas of the triangles given in the above article is hard to memorize and keep in your mind all the time, especially as each one is worked out by a different rule. There is an old English rule which is nearly

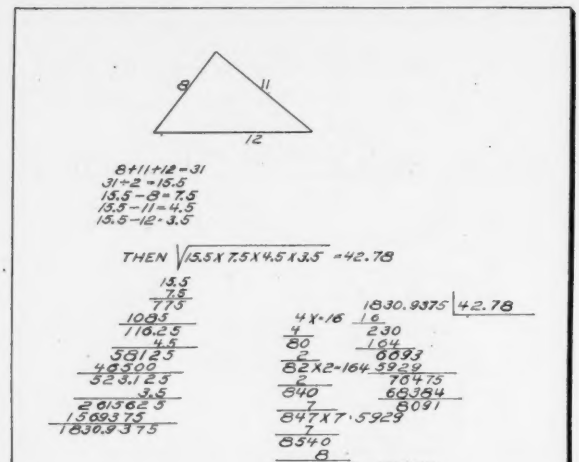


FIG. 1. FINDING AREA OF TRIANGLE BY OLD ENGLISH RULE

impossible to forget once you have done 3 or 4 problems; the rule is: From half the sum of the 3 sides subtract each side separately, multiply half the sum of the 3 sides by their remainders and the square root of the answer will be the area. Fig. 1 shows how to solve the example on page 935, September 15 issue.

To find the area of an equilateral triangle, multiply the square of any one of the sides by 0.433, as shown in Fig. 2.

While I am on the subject of figures I would like to submit a simple way to find the number of gallons in

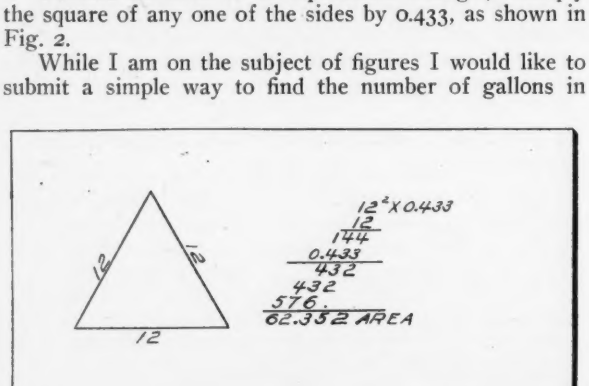


FIG. 2. CALCULATING AREA OF EQUILATERAL TRIANGLE

any size pipe by using a standard multiplier. Multiply 0.0408 by the length of pipe in feet by the square of the diameter of the pipe in inches. As, for instance, take a piece of pipe 3 in. in diameter and 300 ft. long, how many gallons does it contain?

The old way would be:

$3 \times 3 \times 0.7854 \times (300 \times 12) \div 231 = 110.16.$

The new way:

$300 \times 3^2 \times 0.0408 = 110.16.$ John Mitchell.

GAS FIRING

WHEN firing with gas, it is best to install a reducing valve to reduce the gas pressure to 8 or 9 oz.; a gas meter, so as to see how much gas you are using; and a water meter to find out how much gas it takes to evaporate 1000 gal. of water. Take hourly and the daily meter readings, to get a check on what you are doing.

Horizontal return tubular boilers need a bridge wall, or checker work, of fire bricks which should be located about 4 ft. from the end of the burner, and the flame should be directed against this, as the gas striking the hot bricks causes better combustion of the gas.

One should be able to evaporate about 6000 gal. of water in 1 boiler, 72 in. by 18 ft., rated at 150 hp., from 70 deg. F. to 100 lb. steam pressure, on 84,000 cu. ft. of deep sand gas. Shallow sand gas will take a little more, as the gas is not so high in heat units, or, to be plain, not quite so good.

Another important instrument is a thermometer capable of taking the stack temperatures, which should run around 300 deg. F. The stacks must have dampers in them to do any good, and careful experiment is necessary to get the right draft and the right regulation.

It is quite a common practice to cover the grate bars with bricks and stop all air from entering from below, which forces all of the air through the burners. In my opinion, a 6-in. burner would be what should be used on a boiler of the above dimensions. Three of them would be necessary, but 4 can do no harm if proper covers are placed over the air space so as to regulate it.

A white flame is all right. To illustrate this, take a gas jet and let it burn in the air and a white or yellow flame is produced; introduce compressed air and an intensely hot blue flame is produced. Much shorter, but having no more total heat than the other, but it is concentrated. That is what would bag a boiler. Use a good compound. Stop up all cracks in the boiler setting with fire clay, get the feed water as hot as possible and by watching the little things, a gas furnace will give good results. H. L. S.

ECCENTRIC ROD ADJUSTMENT

IN the July 1 issue of Practical Engineer, J. A. Levy writes an article on engine rod adjustment, giving instructions how to find the striking and clearance points for engine pistons.

The method he mentions for finding the striking points of a fixed rod, one that is immovable, is the usual one. But for a screwed rod, I think the following way is much simpler and less liable to mistakes, as there are no measurements considered between the crosshead and loose fitting jam nut.

Place the engine on the head-end dead center, loosen jam nut and screw rod out until it strikes the head. Tie a small string or hook a rubber band around the rod close up to the face of the gland. Now, turn the engine to opposite center and screw rod in until it strikes the crank end head. The engine is now ready to turn back to the head-end center and measure the distance between string and face of gland. The rod is then screwed out of the crosshead one-half of the distance thus measured. This will, I think, give very accurately the clearance points in the engine cylinder.

The jam nut is tightened up and a small punch mark should be put on the base of crosshead and rod near nut; this distance is then measured and kept on record or can be marked off in any convenient place on engine frame. If the striking and clearance point are marked very plainly on the guide and crosshead, the location of the piston can always be determined quickly and in the future could always be adjusted by shimming at the pin brasses. J. W. Dickson.

CHECK VALVE PROBLEM

AS I have read Wm. F. Fischer's solution to H. C.'s question in Aug. 1 number regarding unbalanced pressure on check valve, it seems something more might be said about that matter.

H. C. must think it strange when he observes his gage every day and sees that it never, at any time, under normal running conditions, registers more than 110 lb., after he himself solves the problem at 184 lb., and Mr. Fischer decides 144 is about right, or as he says, 150 lb. or more for good working.

As there is no 1 9/16-in. valve, or 1⅞-in., it must be a 1½-in. valve that H. C. has under consideration, and the actual measurement of the exposed area might be 1 9/16-in.; that means the area exposed to the feed pump, and that is the only area to be considered, as that is the area exposed to the difference in pressure. The outside diameter of valve could be even 2 in. or more and the same pressure from the pump would lift the check, but the weight of the check should be considered, also the resistance in the feed pipes, and this is possibly 10 per cent.

Then H. C.'s problem would be solved like this: $1 9/16^2 \times 0.7854 = 1.926$ sq. in., and $1.926 \times 100 = 192.6$ lb. Assuming that weight of valve is 3 lb., $192.6 + 3 = 195.6$ lb., and the area of the check exposed to feed pump being the same as that exposed to the pressure in the boiler, $\frac{195.6}{192.6} = 101.5$ lb., and 10 per cent for friction, $101.5 \times 1.10 = 111.65$ lb pressure necessary to lift check. P. A. Guttormsen.

WHAT I consider the correct answer to valve question that we find answered in the issue of Oct. 1, is given below.

Mr. Fischer's arithmetic appears to be correct, but his solution is, I believe, in error, and I will endeavor below to uphold my contention that practically it takes but a little more pressure per square inch to open the valve than the pressure which is holding it closed, and if the readers will take the trouble to put a gage just below and one just above a valve they will be paid; the 2 gages will show practically the same pressure.

Referring to the sketch which shows a valve disk whose area is 2 sq. in., covering an opening of 1 sq. in. with a pressure of 100 lb. per sq. in. acting downward upon the top of the valve disk, or a total load of 200 lb. This load is supported by the area around the opening under the valve and this area must be acting upward against the valve with a force equal to the load of 200 lb. on the disk it would be forced down. In other words, there is the same total pressure against the underside of the valve as there is against the upper side.

Suppose we start admitting a pressure through the opening under the disk and as this pressure builds up it starts to take away some of the load that the seat is supporting, until a pressure of 100 lb. is built up in the opening. Then the part of the valve over the opening has a pressure of 100 lb. on either side and the part of the valve over the seat has a load of 100 lb. on top acting downward, and a supporting force from the seat acting upward of 100 lb.; in other words, the valve is in a balanced state; any slight increase in pressure through the hole would put the part of the valve over the opening in an unbalanced state and this part would tend to lift, but of course would have to carry the weight of the disk, that is covering the seat, up with it and thus admit the increased pressure under the whole valve and the valve would rise off its seat.

Thus it can be seen that the pressures at the opening are not proportional to the 2 uncovered areas. If the hole through the seat was only ⅛ in. in diameter, the pressure per square inch required to lift the valve

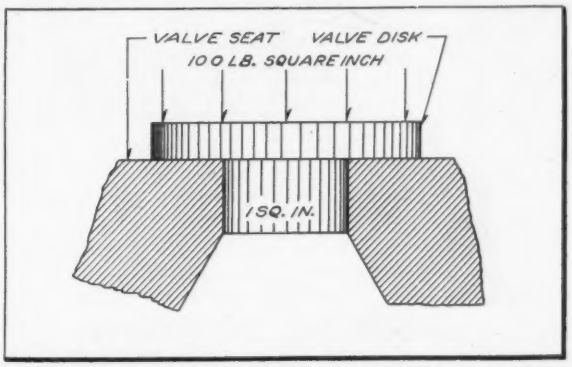


DIAGRAM OF PRESSURES ACTING ON CHECK VALVE DISK

would not be appreciably above the pressure per square inch on top, the only difference would be the weight of the valve itself added to the load due to the pressure.

This valve weight theoretically would increase the force acting downward, but in practice is not noticeable unless the valve is very heavy, which is not usually the case. In pump practice there is usually a spring over the valve whose tension has to be overcome before the valve will rise, but this is usually very slight. In my explanation I neglected both the weight of the valve disk and tension of spring.

C. H. Reynolds.

(The above explanations are obviously both wrong, the errors in reasoning are somewhat hidden and readers are invited to point them out.—Editor.)

A CRACKED GAGE GLASS

WE had a cracked glass on our steam gage at the pumping station, which had been in this condition for several months; one morning the fireman seemed very slow in getting up steam, in fact no efforts of his could cause the steam to rise above 40 lb. All at once the pop valve began blowing off steam, and as the pop valve was set to blow off at 100 lb., investigation was made which showed the pointer on the steam gage had caught in the cracked place in the glass. The glass was promptly taken out. Never have a cracked glass on a steam gage; always have your pop valve in good working order. Robert L. Campbell.

TO CLEAN ZINC ARTICLES, make a paste of rye bran stirred into boiling water and add a handful of silver sand and a little vitriol. Rub the zinc articles with this paste, rinse with water, dry and polish with a cloth.—Penberthy Engineer and Fireman.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Handy Devices Around the Plant

SOMETIMES in need of a wing-bolt, one can quickly be made. Take an ordinary machine bolt of the desired size and with a hack saw make a slit in head of bolt to receive the wing, which is made from

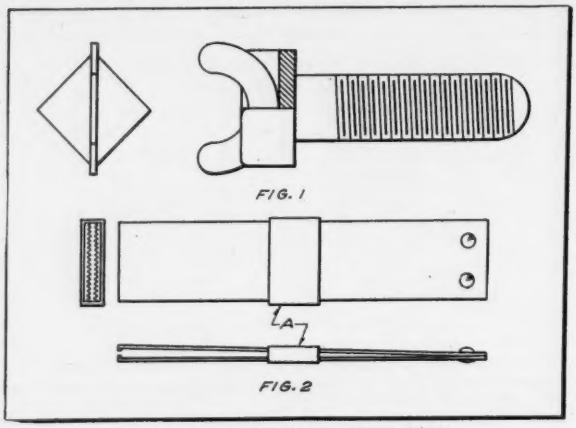


FIG. 1. EASILY-MADE WING BOLT
FIG. 2. BELT LACING DEVICE

a common washer of the size desired. The illustration shows where washer should be cut. Insert washer in slit of the bolt and hammer the head to draw the slit together, thus wedging the wing securely.

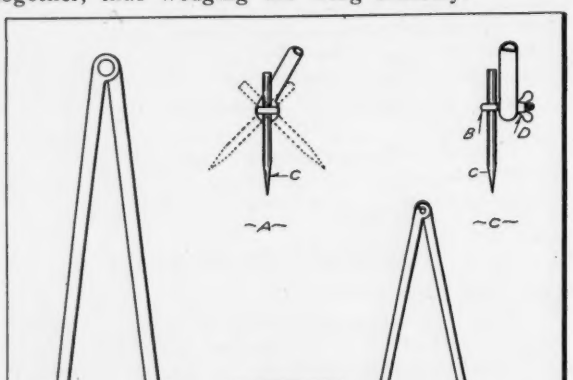


FIG. 3. SCRIBER MADE FROM PART OF BUGGY TOP

We all know how hard and tedious it is many times to lace belts when the hole is a little small for the lace or for other reasons would double up and refuse to go through. The little device shown here will prevent the difficulties. Place the end of lace in between the teeth and push slide A towards the jaw end of the device; this will squeeze the jaws or teeth into the lace and hold it securely while you are lacing the belt. It is made out of a piece of thin iron, about 1/20 in. thick and about 3 in. long bent into shape, with teeth filed as shown in Fig. 2.

A divider can be made from a pointed brace of a buggy in the following manner: Ream out the holes at A, A, to receive bolt B, Fig. 3. Bolt B must be drilled to receive extension points C. These points can be set at any angle, as shown, by loosening wing nut D. The points can be any length, but 5 in. is sufficient for ordinary work and if you so desire, one of a lead pencil may be substituted for one of the points, which will be found very convenient—in many cases better than the steel point. It may also be used as a scriber by adjusting the points as shown at D.

G. H. Holter.

Wedge Bolts for Connecting Rods

WE often have trouble from the wedge bolts breaking in the connecting rods of our high-speed engines and compressors. This trouble usually comes from the wedge being improperly fitted, and again the trouble frequently can be credited to the fact that the wedge is held by 2 cap screws, one on the bottom and the other on the top of the rod; these bolts require considerable strain on them in order to hold the wedge in place and the increased vibration causes the bolts to yield and our adjustment is destroyed. A wedge bolt should have a good, close-fitting thread.

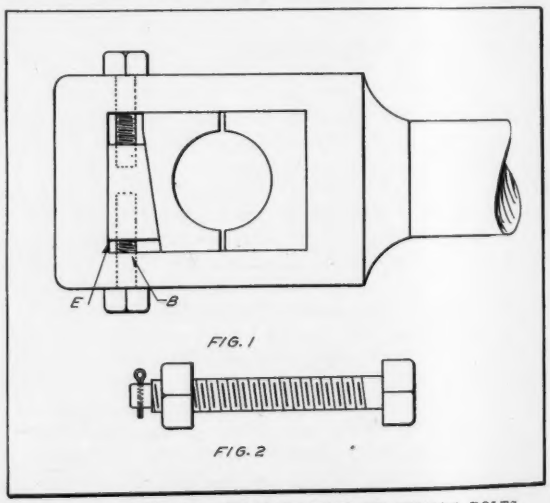


FIG. 1. COMMON ARRANGEMENT OF WEDGE BOLTS
FIG. 2. THROUGH BOLT WHICH GIVES GOOD RESULTS

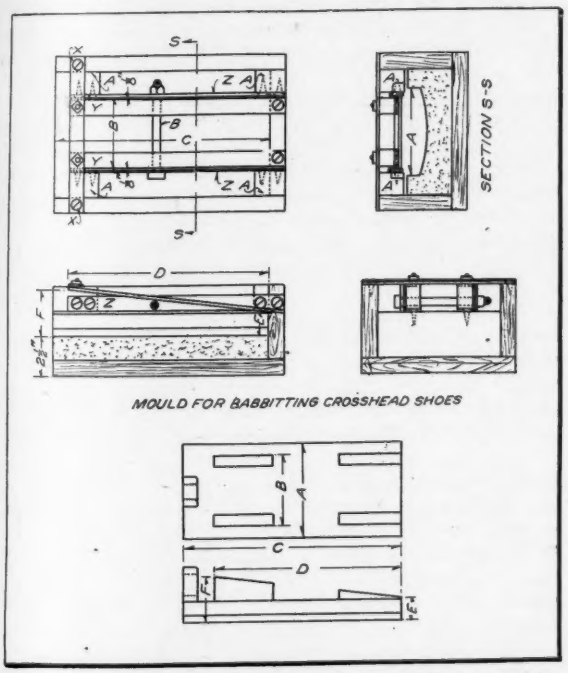
Many of the wedge end connecting rods that are constantly working loose can be made to be more permanent and safe by putting in a through bolt, as

shown in Fig. 2, this bolt having a good, close fitting lock nut and for safety having the extended end drilled for the insertion of a cotter key. I have refitted many wedge ends, that had the 2 common cap screws, with good through bolts, and no further trouble would come from the slacking of the wedge bolts.

In making the through wedge bolt, a good grade of hot rolled soft steel should be used. It is a common practice to make all such bolts from cold rolled stock, but this is unfit, as it is short in fibre and will not stand any great strain without snapping. The breaking of wedge bolts can often be stopped by the insertion of a liner behind the wedge block at the point E, as shown on the drawing. Frequently the bolt will come in contact with the hole in the rod at the point B, and soon break. C. R. McGahey.

Mould for Babbitting Crosshead Shoes

BABBITTING crosshead shoes in the guides is not always a successful operation. Unless the guide is quite warm it will sweat when the hot metal is poured in, causing blowholes in the face of the babbitt. If considerable care is not taken to provide air vents at the highest points, the air is quite likely to be trapped in a corner, thereby shutting off the babbitt



DRAWINGS OF MOULD FOR BABBITTING CROSSHEAD SHOES

and leaving a large corner of the shoe unfilled. Great care is also necessary in sealing around the sides and ends of the shoe.

A few experiences of the above nature led to the design of the permanent mould which is shown in the accompanying drawing. Two sets of shoes have been babbitted in this mould within the past 2 yr., and it has proved very satisfactory.

The bottom and sides of the box are nailed together first, then the front end is nailed in. Notice that the end reaches only a short distance above the bottom and not to the top of the sides. The rear end is left open.

The cross strip X-X is ¼ by 1 in. iron, as are also the strips Y, Y and Z, Z. The strip X is fastened to the sides of the box by wood screws. The 2 strips, Y, are held by wood screws in the end of the box, and by ¼-in. countersunk bolts which fasten them to the under side of X-X. Four wooden blocks, A, are nailed to the sides of the box near the ends, and to these blocks the strips, Z, are fastened by wood screws.

The strips, Y, form a bearing for the top faces of the lugs on the back of the shoe, and the strips Z, form a guide for the side faces of the lugs.

To prepare the mould, invert the box and slip the shoes in as if it were being placed in the crosshead next to the upper guide. Now tighten the nut on the bolt B, thus clamping the strips, Z, against the sides of the lugs and holding the shoe in position. The box is now reversed and the rear end temporarily closed. A rich cement grout is then poured in until it reaches a level slightly below the top edge of the shoe. When the grout is set the shoe is removed, and the mould is ready for use.

A new shoe should preferably be used in forming the mould, to insure a correct bearing and the proper thickness of babbitt. If a worn shoe is used, it should be lined away from the strips Y, to allow for the wear.

The principal dimensions are lettered to correspond with those of the shoe as shown in the lower drawing.

This mould can be quickly warmed when it is to be used, is very easily sealed, and as it is placed on end and poured from the top where there is a large open space, there is no tendency to trap the air.

P. H. White.

Concrete Acid Tank

THE writer, who is connected with an industrial company which does considerable dip-tinning and galvanizing of all kinds of articles, was called upon to investigate the cause or reason for so much acid being used in that department, and upon investigation found that the whole trouble was based upon the fact that improper receptacles were used to hold the acid, into which the articles to be tinned or galvanized were dipped.

I at once suggested a granite or stone tank, properly gouged out to the size and shape required, but this was considered too expensive and elaborate, so the next scheme proposed was accepted. It consisted of purchasing a 12-gal. glazed crock which was set in a rectangular form, and "concreted in," making a concrete tank whose inside was glazed and impervious to the action of the acid. The concrete readily adhered to the outside of the crock and made the whole very solid. In order that the acid could not settle on the top of the tank and attack it, the concrete was given a pitch of 2 in. from the side to the rim of the crock, and is doing the work in good shape.

A. P. Broadhead.

WET BATTERIES usually have the upper part of the glass jars coated on the inside with paraffin, so as to keep the sal ammoniac in the solution from creeping over the top of the jar, thereby robbing the solution of its proper active strength. Where this has not been done, the same result can be obtained by greasing the inside of the neck well with tallow, or with a mixture of vaseline and tallow. Of course any sal ammoniac that has already deposited on the neck should first be scoured off with a moist cloth.

CORRESPONDENCE OF AN OLD ENGINEER AND HIS SON

A Fall Down, a Call Down and a Wiser Man

MY DEAR FATHER:—

Well father, I fell down. I am sorry to say it but I did, and there is no use trying to conceal the fact, for they say that "confession is good for the soul." I was sort of congratulating myself that I was getting along fairly well since I came to work for the Daneberg Mfg. Co., and in a way I suppose that I was.

My work seemed to be satisfactory, so far as I could see, and judge by the way that I have been treated, and promoted (a little at a time), but I guess that it is a sort of a "brake" to a fellow to keep him from getting so swelled up over the job that no one can live on the same side of the street with him.

It all came about this way. We had been repairing a vertical compound pump which it seems was installed here several years ago, some 15 or 18, so they say,—and was used to pump the water for the plant and also to supply several other factories in the near section of the town, as well as a part of the city, although the latter has been taken over by the local water company now.

The amount of water, however, that is required to be pumped now is as much as ever, owing to the growth of the plant, so it was determined to give the pump a good overhauling. This has been a long job and one that I could write all week about, but I want to tell you first how I put my foot in it and sort of got myself in bad all 'round.

The engine is a triple expansion with cylinders 18, 30, and 42 by 30 in. stroke. The first receiver pressure is about 10 to 12 lb., and the second receiver pressure is about 4 to 5 lb. minus.

The high-pressure cylinder is jacketed with steam at boiler pressure and drains to the receiver pump in the basement without a trap, as it is a full pressure gravity drain system. The intermediate cylinder is jacketed with steam from the first receiver and this jacket is drained by a trap which also takes care of the drainage of the receiver and the lower heads.

This trap discharges into the jacket of the low-pressure cylinder where it flashes into steam at a lower pressure. The drainage of this jacket passes on down to the basement where it enters a water seal of a depth sufficient to take care of any possible vacuum that may ever be in the system. The overflow of this water seal has 2 outlets, both taken off a tee, and each supplied with a valve so that either one can be used.

Right here is where I spoiled my reputation. The chief figured out this scheme and it is so totally unlike anything that I ever heard of before that I doubted whether it was feasible or not. He explained it all to me and laid great stress on the methods of taking care of the condensate after it had passed through the seal. By opening one valve, it went to the sump and by closing this valve and opening the other one it went to the line leading from the hotwell to the plunger boiler feed pump.

"Now, Mac.," said the chief, "this is a particular job and I want it done right. Over here, where this seal enters the pump line, I want a check valve set to pass the condensate on to the pump. Do you get that?" I said that I did, and went to work. It was a brass pipe job and I felt proud to think that I got the particular job to do.

I was not so familiar with check valves then as I am now. I looked the valve over carefully several times, and went over the proposition again in my mind to be sure that I was right. Well I finished the job and felt a great pride in the work, but afterwards when the chief read the riot act to me, I thought, "well, pride goeth before a fall."

When we were all ready, we started up with the sump connection open, and let the dirt and oil wash out of the pipes before feeding the water to the boiler. The seal operated all right and the chief was much pleased with his invention so far. Then he told me to go down in the pump pit and change over which I did, turning the condensate into the line to the boiler feed and watched for results.

It was quite dark in that corner and I stood with one hand on the pipe waiting for it to get warm but it didn't. There was nothing pressing just then and I was sort of lost in reverie with waiting, till the chief yelled down through the crank well and asked for information, and when I told him that it didn't seem to work, he was 'visibly annoyed.'

Finally he came down, and looked the thing over as well as the gloom would permit. Then he lit a match and stepped down into the sump—and into 4 in. of water too,—and found that with all my pains I had put the check valve on the back end to.

Well sir, the chief looked at me as if I had blown the whistle on Sunday, and I felt myself getting smaller and smaller like a pack of trick cards till finally he said with considerable warmth, "Well you-are-a-bright-genius,-aint-you. Here you have turned my hair gray and a thousand other things, just because you don't know the way water ought to go through a check valve!"

Well there I was, no excuse to offer, and I just had to stand there and take my medicine like a little man. After he had said all that he possibly could say, I changed the valve, and the water seal that the chief had spent many an hour and evening to perfect, went off about its business like an old hand.

Of course, there is no such a thing as keeping things like that from the gang, and I have not heard the last of it yet. The boys never lose a chance to remind me of it and sometimes, father, it hurts, too. I would sooner have a fellow come up to me with blood in his eye and have it out than to have him walk over to a fellow at the next bench and say, pretty loud, "I hear that the chief is going to have all the check valves put on t'other end to, all over the plant."

Well for all that, this repair job is an interesting place, all in all, and I am glad that I changed. The chief has gotten over his grouch a little, but for 2 weeks I never went up to call on Hazel until one day, the chief asked me if I would come up that evening and help him move the stove?"

After the stove was arranged to suit him, we ate apples and talked a while, and finally he asked me if I could draw. Well, if there was one thing that I could do better than another back at Tech. it was drawing, so I told him that I had had some experience.

Next day he was as friendly as ever and had forgotten all about the check. But let me tell you, father, that it is a sudden bump for a fellow that has always had a good record, to fall down on so simple a thing as a 1-in. check valve.

But the drawing. Next afternoon he asked me to come into his office and when he had shut the door, he said that he was going to change the screw machines around so as to economize space and could not make a good sketch. He took a pencil and paper and made a freehand drawing of what he proposed to do, that was a work of art. I have seen plenty of men that were expert draftsmen and who could not make a sketch of a hexagon nut so it looked like it, but here was a Chief Engineer, one of the old school, who could make a sketch with the stub of a pencil that was real art.

He told me what he wanted to do was to set all the machines at an angle so that the stock would pass back of the man's machine on the left and not inconvenience any one. He had a drawing board made for me and next morning I went into his office and made the sketches that he wanted. This seemed to please him pretty well and I guess that I have sort of redeemed myself.

Well father, it is now after 9 o'clock and I must close. Maybe I will take a run home Christmas and see you. It has been quite a while since I was home, not since the year before I left Tech., and I want to see the old home again mighty bad. I will try and arrange it with the chief for 2 weeks off. You will be surprised at me I know, for a year at school, and 2 yr., most of the time on the south end of a No. 5 scoop, have added about 40 lb. to me and I begin to feel that I am at least beginning to make good.

So give my love to mother, and tell her to lay in a good supply of real pies, real turkey, real bread, like "mother used to bake," and real doughnuts. This boarding is all right I suppose, but when it comes right down to brass tacks, there is no place like home, and no cooking like mother's.

I wanted to say a lot more, but it is too late tonight and I want to get a good night's rest for I find so early in the game of life that if a fellow wants to feel good next day, he has got to get to bed early.

Your loving son,

Donald C. MacDougal.

INCREASING CAPACITY OF AIR COMPRESSORS

By C. R. McGahey

THE accompanying illustrations show how the capacity of an air compressor was increased. There are, no doubt, many of our air compressors that are not delivering the proper volume of free air for the amount of steam they are consuming, and many of these cases are where the valves and valve passages have not been properly designed. Many compressors are in use of like dimensions that will not deliver a like amount of air for a given piston speed.

Figure 1 shows a common type of air compressor valve, the seat of this valve is shown in Fig. 2 and has an air passage 2 in. in diameter, so we find the area of this to be 3.1416 sq. in., consequently the openings above this should give a free air passage of the same cross section, if not the passage will cut down the ultimate capacity of the compressor.

We found a machine in this shape, the lift A was not sufficient, the stop piece E was too long and so was cut off as shown by the dotted lines and this allowed the valve to give a free passage. The port holes were checked up and found to have the proper area, but the parts that lead from the surface of the piston to the valves were not large enough and these were chipped out to the dotted lines as shown by C and D Fig. 3. The outlet valves were also too cramped for movement and the stop collars on these were also cut off to allow more movement.

In some cases it is found that the springs are too heavy and especially on compressors working on a low pressure service such as pumping from wells. We sometimes find compressors working more on one end than the other, This is caused by the piston being out of the center of the cylinder. A compressor piston should have the same amount of clearance at each end. Compressors as a rule are very wasteful due to low efficiency of the machine and when we find them with one valve not working or loose all together then they are very extravagant of steam.

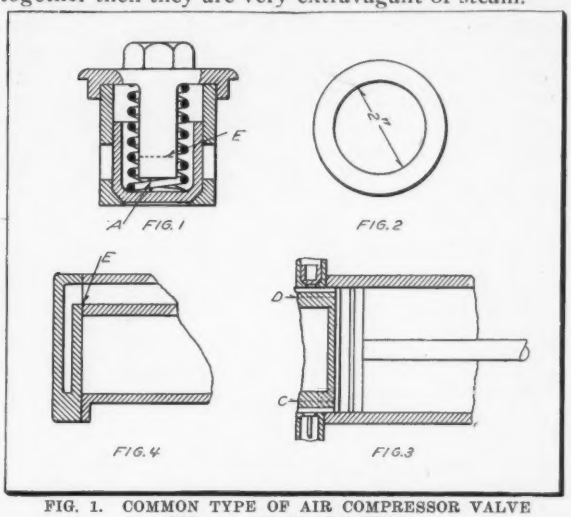


FIG. 1. COMMON TYPE OF AIR COMPRESSOR VALVE
FIG. 2. AIR VALVE SEAT
FIG. 3. METHOD OF INCREASING AIR PASSAGE
FIG. 4. POINT WHERE LEAK FREQUENTLY OCCURS

The compressor which has the valves in the heads, and the valves usually lay on a horizontal line with the piston, we have found to have a hidden leak through the point at E, this space between the surfaces being so small as to make it difficult to keep packing in this bridge and it has been found necessary to cut a small groove in this portion so as to hold the packing from blowing out. This is a common leak in this type of compressor.

THE PEOPLE'S COTTON OIL MILL, Sulphur Springs, Texas, now in course of construction, will open for operation about December 1. The plant is being built at a cost of $75,000 and will furnish employment to over 50 men. Many additional buildings are being erected here at present, also several thousand yards of concrete sidewalks are being laid. In all, something like $300,000 is being expended in improvement work.

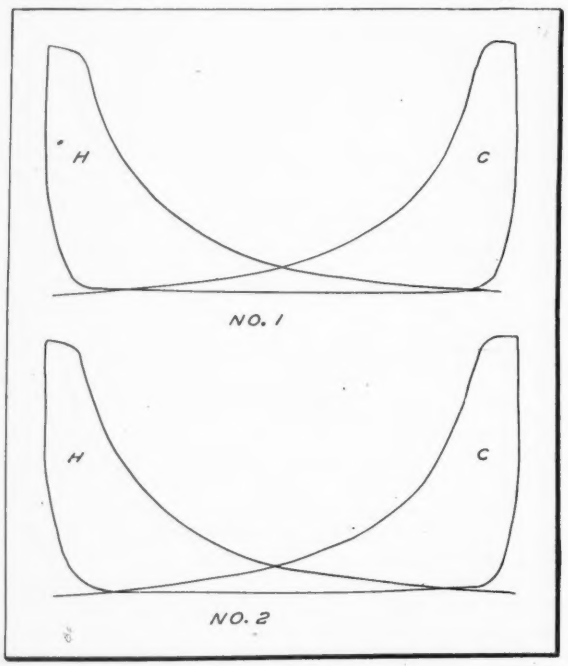
ONE OF THE MOST useful of the common cements is litharge-glycerine cement, which is waterproof and strong. The ingredients, however, must be free from water to insure success. Before mixing a batch, mix up a small pellet and lay it aside to harden. If it does not harden in 15 to 20 min., the probability is that either the litharge or glycerine contain water, or both. The litharge should be carefully dried at a low temperature and the glycerine heated over a slow fire until the water is driven off. The litharge and glycerine should be thoroughly mixed, using as little glycerine as possible to thoroughly incorporate, and then add glycerine until the required plasticity is attained.—Machinery.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Pounding in an Engine

I AM sending you some cards taken from 22 by 42-in. Hamilton-Corliss engine operating at 92 r.p.m. The boiler pressure was 100 lb. and the scale of indicator spring 50. If I give the engine the proper amount of compression I get a very bad pound in the bearings; when I relieve that there is pounding in the head and exhaust valve.



CARDS FROM A HAMILTON-CORLISS ENGINE, NOS. 1 AND 2

After setting the valves and taking cards several times the pounding still continued. I have tried advancing the eccentric, but nothing helped it. Will you kindly offer some suggestions? C. G. T.

A. As all 4 cards submitted show approximately the same point of cutoff, we take it that this represents your normal load and that which you have to deal with most, if not all of the time. If this is so, then practically all of your trouble lies in carrying too high a steam pressure for the load.

These cards all show a cutoff of about 5 per cent from 150 to 155 i.h.p., whereas your engine ought to develop approximately 350 i.h.p. with 100 lb. steam pressure and at its most economical rating, which would mean a cutoff of about 22 per cent.

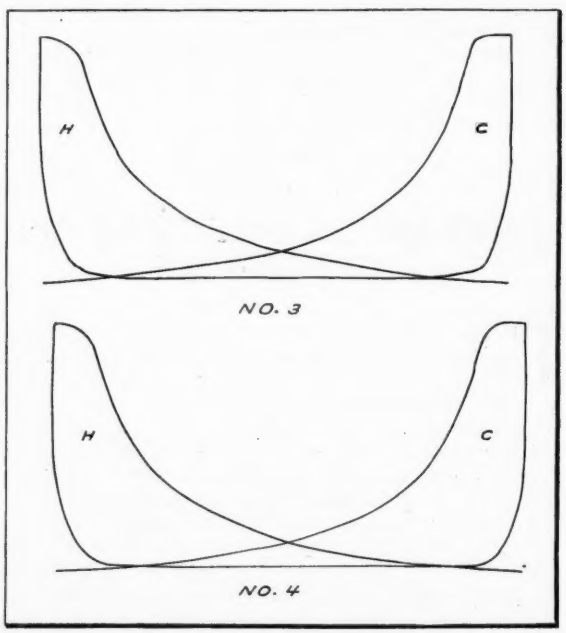
Practically all of your noise is caused by underloaded conditions and we suggest that you reduce your boiler pressure to the point where you will have a cutoff ranging from 20 to 25 per cent of the stroke. This, we would say, would be about 70 to 75 lb.

Look well to the pins and bearings and see that they are snug and also the crosshead shoes so that there is no lost motion. Any looseness in these parts will be greatly aggravated by just such conditions under which you have been operating.

We believe that card No. 4 shows a compression curve about what it should be for your conditions. Do not give it more compression, as it shows about 8 per cent now, which is plenty for your speed and pressure, and would also be all right when you lower the boiler pressure.

Cards Nos. 1 and 2 show that admission is a little late, and we suggest that you give the engine a little more lead, either on the steam rods direct or by advancing the eccentric on the shaft a small amount, say an eighth to a quarter of an inch on the shaft. If you advance the eccentric, adjust the exhaust rods so that the compression will not be increased any.

The point of cutoff being so early, and the expansion curve being run down till it meets the atmospheric line, it is impossible to say anything about the point of release, but when you reduce the steam pressure, the point of release will begin to show up and define itself so that you can determine whether or not it is necessary to adjust your valve mechanism to enable release to take place at the proper point.



CARDS FROM A HAMILTON-CORLISS ENGINE, NOS. 3 AND 4.

The load is divided up very evenly between the 2 ends, and is as close as is possible under ordinary operating conditions. G. H. Wallace.

Erecting a Boiler

PLEASE explain the best method of installing a 50 or 60 hp. return tubular boiler. What is the best way to jack the boiler up to receive the brick work? The boiler in question has loops, column and beam supports. Please state in your answer also the best way of raising smoke stack. How low should the rear end of boiler be? J. L. R.

A. As we do not know what type of boiler front you will have we will assume, for the sake of instruction, that it is the "full front overhung" design. Move the boiler onto the foundation in the most convenient manner that is possible and locate it approximately where it will stand with reference to the general arrangement of the foundation.

Then place a stout timber, say 8 by 8, across under each end and of such a length that it will be about 4 in. shorter than the inside measurement of the finished wall. Use jack screws under these for raising the boiler and when you get a strain on the jacks and before you begin to raise it off the skids, spike a "cock" to the blocks to prevent the shell from rolling.

If possible have a man at each of the 4 jacks and have them raise the jacks all together, taking care in the meantime to follow up with substantial blocking to prevent a possible accident. When you have raised the boiler to the approximate height make everything secure and proceed to erect the columns and beams.

If you have plans, they will show the distance apart of the columns and if not the location of the loops on the boiler shell will assist materially in locating them. Brace the beams to each other with cleats spiked to planks or timbers, 4 by 4's will do nicely.

Brace the columns so that they are rigid and in the right place. Place the loop bolts on the boiler and let them project up through the beams, and put on the nuts and washers. Lubricate the bolts with graphite and oil and it will save you a lot of hard work,—and possibly some trouble.

Draw up on the bolts until the boiler is clear of the blocking underneath, and level it crossways by means of a level laid across the tubes inside the manhole, or across the machined flanges on top. In leveling the boiler lengthways, set it so that the back end will be about an inch to an inch and a quarter lower than the front end, depending on the length.

The boiler should now be in a position so that the lower half of the front can be slipped under the shell and resting on temporary wedges so that the bottom is about on a level with the floor line, or a little above it for a small boiler.

If it can possibly be done, leave the blocking under the boiler and built up to it snugly until the brickwork is completed, when it can be removed through the fire doors. Having located the boiler, it but remains to brick it in, placing the rods, braces, dead plates, door frames, and other extras in their proper places as you go along, not forgetting the water column and feed water connections, if they enter the boiler through the brickwork.

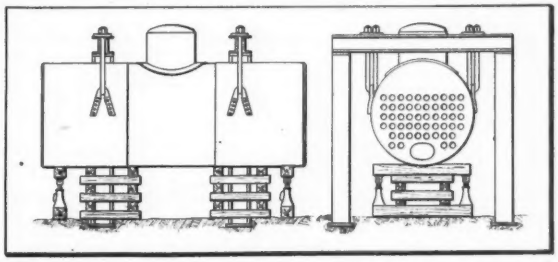
To raise a smokestack successfully, the main part is in getting ready for it. The method of procedure varies somewhat with the location of the job and the surroundings. A "gin pole" must be provided of such a length and strength that a block and fall suspended from the top will raise the stack high enough so that it will clear all obstructions in putting it in place, even to raising it high enough to drop it through a hole in the roof.

From the top of the gin pole suspend a suitable block and fall, using not less than 2 or 3-pulley blocks and a rope known to be equal to the task. Estimate the weight of the stack. Multiply the total length of the stack by the circumference and by 5. The result will be the weight in pounds of every eighth of an inch in thickness. Select a rope and falls that will do the trick easily.

When attaching the top block to the top of the pole previous to raising it, arrange for 3 or 4 guy lines to hold the pole in the proper position when it is raised. Sometimes it is convenient to have a small block and fall as a part of each gin pole guy rope, so that the top of the pole can be shifted a small amount to bring the stack in place better.

Now raise the gin pole, using the best means at hand, as it ought not to be hard to handle if the stack is small, and arrange the guy ropes and fasten them to posts, trees or buildings in a substantial manner.

Lay the stack in such a position so that a point about two-thirds the height from the bottom is right in under the block and fall from the gin pole, or near as boiler or other obstructions will permit.



ERECTION OF A BOILER SHOWING BLOCKING AND SUSPENSION BOLTS

Make a good hitch around the stack and attach the lower block. This hitch must be made in such a manner that the rope can be easily removed after the stack is up. Attach the guy lines to the stack of such a length that they will reach several posts or buildings at about 4 points to stay the stack when in position.

Pass the hoisting rope through a snatch block near the bottom of the gin pole and draw up the slack. If necessary, use 2 small ropes attached to the bottom of the stack to guide it around possible obstructions. Look everything over carefully to see that there will be no "mixups" or failures.

Hitch a team of horses to the end of the rope and with several men to assist and keep the guy wires and ropes from getting tangled up, give the signal and when the stack has been raised so high that it can be put in place, carefully pull it over the breeching or base and slack up with the team until the stack comes to rest in place, after which attach the guy wires to the places provided for them, pulling the stack as necessary so that it will stand plumb both ways.

IN TAKING DOWN an engine care should be observed in marking the different parts, as the manufacturer frequently omits this important detail. Take the valves for example; many times one valve is worn more than the other and will not seat properly except in its original position although they may have been interchangeable when the engine was new.—Gas Power.

A NEW ELECTRIC light plant is to be completed and placed in operation about the middle of December, at Conde, S. D.

Pump Trouble

THE duplex boiler feed pump hammers when the water becomes hot in the heater and stops hammering when enough cold water is admitted to the heater to cool it. Can I remedy this trouble by placing an open stand pipe, at point A in the illustration, to give the pump a full supply without drawing through 3-in. line, or can this trouble be stopped some other way? Water line in heater is 3 ft. above the pump. J. S.

A. To pump hot water, and especially water as hot as 210 to 212 degrees F., it is absolutely necessary that the water flow into the chambers back of the moving water pistons without any effort on the part of the pump itself. If the water does not readily follow the pistons, and the pump is required to induce this flow, a partial vacuum is formed, and as water vaporizes in a vacuum this vapor will prevent the water filling the entire space in the cylinder.

In order that the pump will give satisfactory service, as far as handling hot water is concerned, 3 things are necessary. First, there must be head enough on the water at all times to force the water

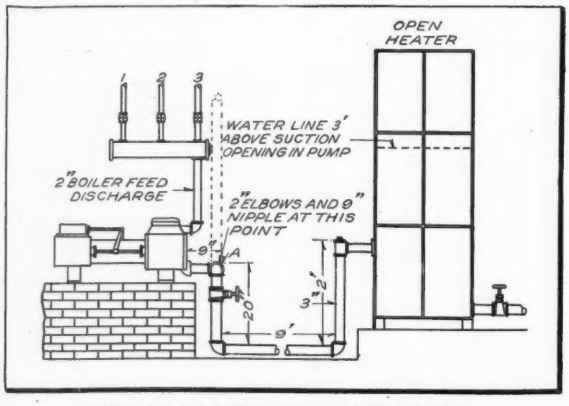


DIAGRAM OF PUMP AND HEATER PIPING

from the heater to the pump; second, the suction pipe between the pump and heater must be of ample size to permit this rapid flow, and free from tortuous passages, such as globe valves, or numerous elbows and fittings; third, the springs in the suction valves, of the pump should be very weak, only strong enough to insure prompt closure and prevent sticking open, and yet not so strong but that the water will readily flow through them the instant the piston begins the stroke.

Where the distance between the pump and heater is great, the suction pipe should be increased one size, as in course of a short time a small pipe will become coated with a rough scaly formation which will tend further to obstruct the passage of the water.

We would advise in your case the the pump be lowered as much as possible or the heater raised at least 18 in. Then examine the suction valves and if the spring is at all stiff, compress the coil enough so that when in operation, water will readily flow through the valve.

We are of the opinion that the standpipe proposition which you suggest, would not remedy the trouble. In fact at a higher piston speed than usual, or when the engine is just shut down and a partial vacuum formed in the heater, as it will, the tendency will be to uncover at the T near the pump (as at A).

The discharge line as shown in your sketch, does not affect the working of the pump, as far as the problem is concerned. A gate valve is much preferable to a globe or angle valve in the suction line of a pump, and should be placed close to the heater.

G. H. Wallace.

Pump Trouble

OUR Goulds pump which supplies water for our condensing coils has a 2½-in. intake and a 2¼-in. discharge.

This is more water than we require and we have reduced the intake to 1½ in. We now have an opportunity to cheapen our water supply by tapping the 2½-in. pipe and drawing the water about 600 ft. at an elevation of about 8 in.

Please advise us whether it is practical to draw water through 2½-in. pipe with 1½-in. intake. We do not wish to enlarge our intake, as it would require extra power to pull the pump and we do not need the water. L. W. R.

A. We would not advise you to reduce the size of the suction of your Goulds pump, especially when you propose to draw the water some 600 ft., even if the source of supply is about at the same level as the pump. The friction of the water in the pipe is considerable and if the suction pipe be smaller than the pump calls for, it will entail some loss owing to friction which will be a constant expense.

We presume that your pump is of the triplex plunger type, driven by a belt or perhaps a motor. In this case the proper way is to regulate the speed of the pump so that it will furnish just about the required amount of water for your needs.

This can be done by changing the ratio of the pulleys that drive the pump so that the right speed is maintained. If the pump is driven by a motor change the ratio of the gears to reduce the speed or else put in a variable speed starting box or controller.

The pump will raise water all right with the suction line reduced to 1½ in., but it will not be so reliable as if the suction pipe were full size. Power driven triplex pumps are sometimes driven by a 3 or 4-cone pulley, the same as a lathe, so that the pump can be operated by any one of several speeds as the requirements for water may demand. G. H. Wallace.

Heating Problem

WILL you please answer the following question? Our boilers are worked to about their capacity and the management wants to heat a 4-room dwelling with steam from these boilers; this dwelling is 700 ft. from the plant. The pipe will be in the ground and be covered with a board box.

Will you inform me about the amount of steam this will take, and if it will be noticeable on the boilers? Will a 1¼-in. pipe be large enough to supply steam to the heaters at distance given? S. S. S.

A. You do not state whether the dwelling in question is of brick or wood construction. In brick dwellings 1 hp. will heat from 15,000 to 20,000 cu. ft. and in wooden dwellings, 7,000 to 10,000 cu. ft.

It is customary to allow 1 sq. ft. of radiating surface by direct radiation for every 60 to 80 cu. ft. of contents. Assuming dimensions of the rooms to be 12 by 12 by 12 ft., the cubical contents will be 6912 ft., which would require approximately 1 hp. You will

require approximately 115 ft. of radiating surface, which at the distance you state in the boiler, at 1½ to 2½ lb. pressure, would require a pipe line between 2½ and 3 in. diameter. It would be advisable, however, for you to use as high a pressure as 10 lb., which a 2-in. pipe should handle without difficulty. N. G. M.

Criticism of Engine Card

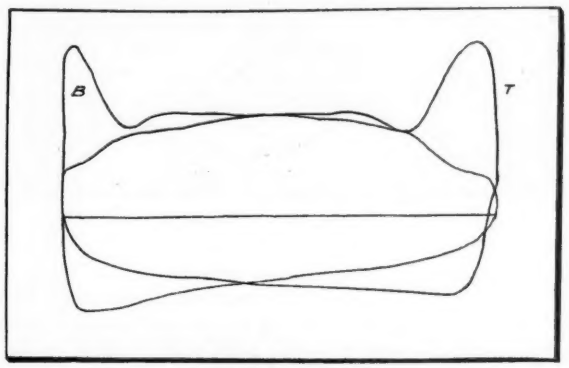
KINDLY point out the defects of the enclosed diagrams, also how to remedy them and when the trouble is in the valve. Card taken from L. P. engine of triple expansion, 15 by 22½ by 36 in. by 18 in. stroke, steam pressure 190 lb.

When card was taken, data was as follows: L. P. engine cutoff, 15 in.; 1st receiver pressure, 70½; diameter of cylinder, 36; 2nd receiver pressure, 16½; scale, 10; revolutions, 210; vacuum, 25½; rod, 3½ in.; boiler pressure, 185. C. R.

A. While you have been very liberal in supplying data in connection with the card which you have submitted for criticism, yet we are still in doubt as to several things which would make the solution of the problem easier if we but knew them.

We take it, however, that the engine in question is a triple expansion, perhaps direct connected to a centrifugal pump, and that the water raised by the pump is the cooling medium in connection with a surface condenser, the necessary vacuum being supplied by an independent air pump.

In all probability the valves are either plain slide valves or else piston valves. If we are correct in the



CARD FOR CRITICISM

diagnosis as set forth above, we will say first that while all the events in the cycle are late and that to advance the eccentric would help matters some, yet the tardy manner in which the steam leaves the cylinder and passes to the condenser leads us to believe that the ports are too small for the speed at which the engine is operated (210 r.p.m.)

At the moment the piston begins the stroke, there is an accumulation of steam in the receiver; but as soon as the speed of the piston is accelerated the pressure drops suddenly. There may be other causes which aggravate this defect but which cannot be determined owing to lack of familiarity with operating conditions.

Of course the point of maximum drop which occurs when the piston is advanced about 3 inches in the stroke, may be caused in part by the indicator owing to the high speed.

If it is possible to advance the eccentric on the shaft a little, and secure an earlier cutoff, this will help some as the terminal pressure will be lower, which will bring the exhaust line lower on the card.

An engine running at that speed really ought to have more compression on account of the heavy reciprocating parts and the frequency with which the movements of these parts are reversed.

G. H. Wallace.

Throw of Eccentric

IF the throw of the eccentric of a slide-valve engine was increased, would it change admission, cutoff, release or compression? If so, how would it change them, and why? C. G.

A. If the throw of an eccentric of a slide-valve engine should be increased, the admission would be earlier, cutoff later, release earlier and compression later. This will be plain to you if you will examine the enclosed diagram.

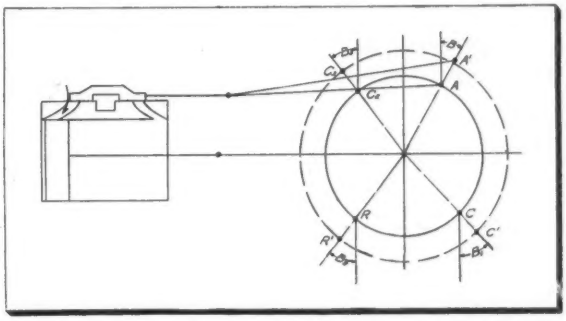


DIAGRAM SHOWING EFFECT OF VARIATION IN THROW OF AN ECCENTRIC

In the diagram, the piston is at the head end, at dead center, and the valve is just at the point of admission. Let A represent the position of the valve rod on the original eccentric. If the throw is increased to A^1, the distance traveled at any period in the first quarter of the stroke will be greater by the angle B. Passing to C^1 at point of cutoff, it will be seen that the original throw is ahead of the new position by the angle B^1. At the point of release, R and R^1, a greater throw would be ahead by the distance, B^2, and at the point of compression, C^2 and C^3, the larger throw would be behind the original throw by the distance B^3.

N. G. M.

Starting a Corliss Engine

MR. WALLACE'S article in the Oct. 15 issue of Practical Engineer contains much good instruction, but he did not mention one of the most vital reasons why a man will get stuck trying to start a Corliss engine. He forgot to mention the stop motion pin or collar on the governor. I have seen men who were trying to start a Corliss engine for the first time who could not move it and would claim that their predecessors on the job had maliciously harmed the engine, when all they had done was to shut the throttle and not bothered with the pin, as they didn't have to start her up. Now, I think it is especially important, as you could not even warm an engine up if you did not have the pin in place. Edgar G. Schindler.

TO ANNEAL STEEL having hard and soft spots, remove the scale, and heat slowly and evenly to a little above a dark red. Immerse in fresh water until almost cool. Heat immediately to a dark red and anneal in the usual way.

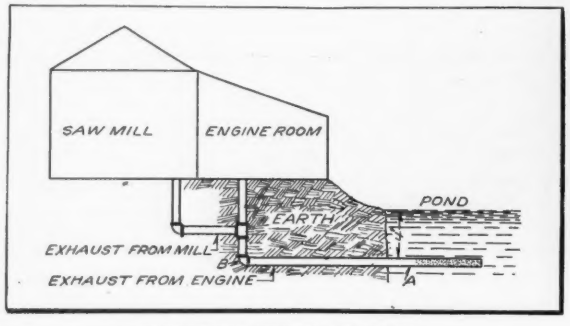
Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Exhaust Pipe to Pond

RELATIVE to the question by J. F. D. on page 992, October 1 issue of Practical Engineer. The following is submitted for his consideration. As shown by the sketch, I think it would be best to sink his pipe into the earth to such a depth as will bring the horizontal length of pipe which reaches into the pond, 4 ft. below the surface of the pond. The exhaust line from the mill can be connected to that from the engine room as shown, the pipe being buried protects it from the frost and does not increase the back pressure.

I would put a check valve on at A, about 3 ft. from end of pipe, the purpose of the check valve is not that of lessening the back pressure but rather to lessen the volume of water which would otherwise



SUGGESTED PIPING TO POND

be in the pipe, so that the inertia will not be so great and the engine will have freer exhaust. I would drill a great many holes in that part of the pipe beyond the check valve to diminish the tendency of the exhaust to splash and scatter the water, especially should these holes be bored in the sides and bottom of the pipe rather than on its topmost side. If it is desired an extra ell and a short piece of pipe can be placed in the line as at B, then with a hook and a boot the piece of pipe extending into the lake can be raised up to examine it or repair the check valve without disconnecting anything or removing a great lot of the soil which covers the pipe, being sure, of course, to use plenty of graphite and cylinder oil when puting the pipe together. All back pressure against the piston on engine is harmful, but the back pressure you will have from a 4-ft. head will not be a serious factor.

Thos. C. Robinson.

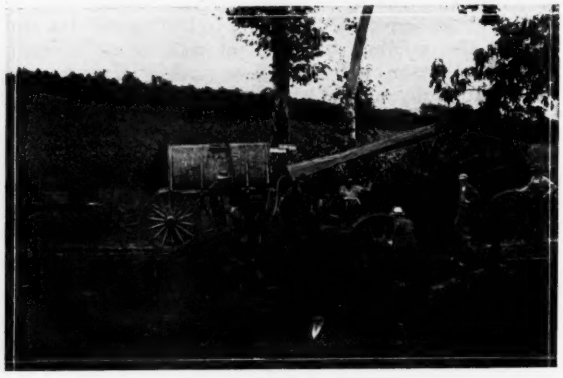
Well Water Problem

I AM a constant reader of Practical Engineer, and I have a question I should like to submit to brother engineers. I have a number of open wells, about 100 ft. apart, and I want to syphon water from all of them at the same time. Can I lay a main with a branch pipe to each well and get the results I am after; and will it pull the water from all alike? I have never seen or heard of a proposition like this undertaken.

E. G. K.

Packing for Grading Engine

I SHOULD like to have the advice of the readers of Practical Engineer as to what kind of a gasket would be best for me to use in a 20 hp. grading engine carrying 140 lb. of steam. The original gasket between cylinder and bed was made of sheet lead and has grad-



GRADING ENGINE IN TROUBLE

ually crawled out and caused a leak. Would sheet copper do for this gasket and how thick should it be?

Accompanying illustration shows our engine after going through a bridge 12 ft. high over 3 ft. of water.

H. H.

Correspondence Instruction

IN the Oct. 15 issue of Practical Engineer there was a question asked by Oliver W. House, "Can One Learn Engineering by Correspondence?" We have received numerous answers to this question, which are of such length that it is impossible to publish them in full. We have quoted pertinent paragraphs from each contribution which are published below.

Editor.

"That depends on the man. It can be done, but not by correspondence alone; practical experience must go with it to make it successful."

J. C. Hawkins.

"From my own experience I should say no. Practical engineering is not found in book form."

Fred E. Anderson.

"A man can certainly learn the engineering business by correspondence under certain conditions. I started in the business 5 yr. ago as an ash wheeler

and settled down to study. I am now ready to take my first-class engineer's examination, having passed all other grades in Massachusetts."

Edgar G. Schindler.

"My answer to this question is yes, but not by correspondence alone. If a man is already employed at engineering and cannot attend a school where he will get personal instruction, the next best thing is a correspondence course."

Frederick M. Perras.

"Engineering can be learned by correspondence, and further, engineering can be learned from text books without correspondence. Either method requires systematic grinding and a long, tedious course of study." L. B. Hodge.

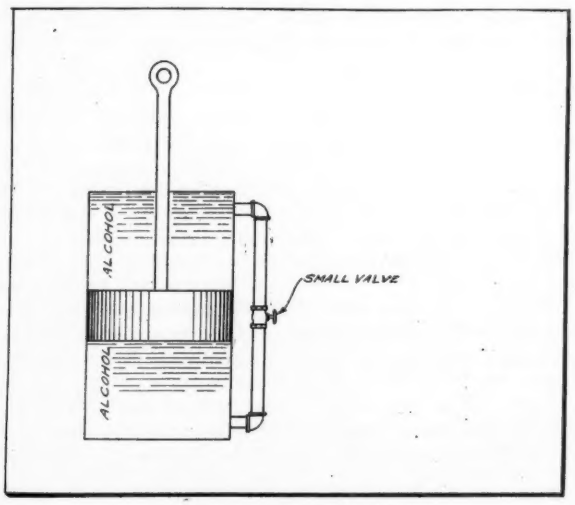
"It is a question which may be correctly answered either affirmatively or negatively. The prospective student should conscientiously answer such questions as these: 'Am I of a studious nature?' 'Am I easily discouraged?' 'Do I earnestly desire to learn engineering or will I tire of it in a few months and wish to attempt something else?' If such questions as these are carefully considered one may be later relieved of listening to the encouraging (?) remark, 'I told you so.' P. H. W.

"If Mr. House means steam engineering and is following this vocation and thus learning every day the practical application of the technical knowledge he is acquiring through his studies, I would say it not only can be done, but it is the greatest opportunity ever offered a man who desires a technical education but is so situated that he has at the same time to provide a living for himself and often a family besides. Still it all depends on the student himself."

R. Cederblom.

Fluid for Dashpots

ON page 1100 in the November 1 issue of Practical Engineer, Mr. Kitz asks for some suitable fluid for use in dashpot. I would advise him to use alcohol,

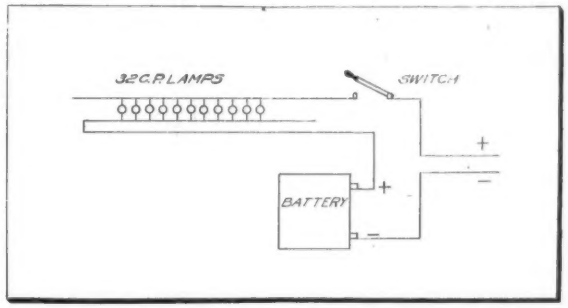


CONSTRUCTION OF DASHPOT

and in place of a hole in the piston, use a bypass of small pipe and a valve to be regulated to suit condition. John T. Lindstrom.

Charging a Small Battery

UNDER the above heading on page 1039, October 15 issue of Practical Engineer, J. D. Henderson submits a sketch showing how he charged a small storage battery from an electric light circuit. The sketch herewith shows how I accomplished the same

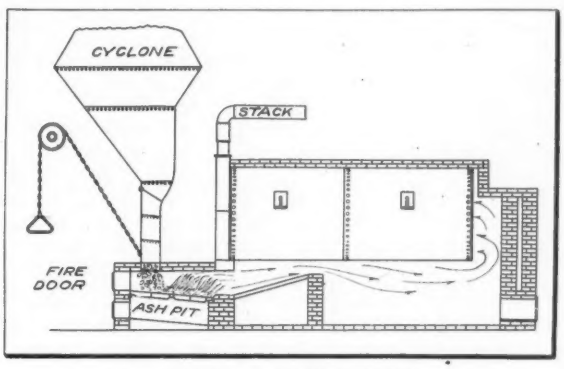


CONNECTIONS FOR CHARGING STORAGE BATTERY

result. I can charge 8 batteries at once and in a 23-hr. charge can use the cells for a mileage of 800 to 1000 on a 4-cylinder car. W. S. Heckendorn.

Burning Shavings

WILL some of the readers give me their experience in burning shavings in the so-called Dutch oven? I understand they are used to some extent in the west.



SKETCH OF A DUTCH OVEN

I should like to know how they are constructed, also if coal or other fuel can be burned at the same time.

Accompanying sketch gives my idea of a Dutch oven. B. O. G.

Running Pumps with Compressed Air

IN reply to P. R., page 1098, Nov. 1 issue of Practical Engineer, we have several duplex pumps 2000 ft. from power plant which are driven by compressed air. I use a small stream of water from the delivery line to pour over steam chest, which allows it to trickle over the sides of the cylinder and prevents the exhaust from freezing. In some cases we submerge the pump and run the exhaust above the water line; otherwise it will cool the water to such an extent that the pump will eventually freeze, as it is commonly termed but it is nothing more than the formation of ice in the exhaust ports, caused by expansion of the air.

W. H. Simmons.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

At 537 So. Dearborn Street, Chicago, Ill., by the

TECHNICAL PUBLISHING CO.

New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Subscription Price, One Dollar a year in advance to any Post Office in the United States or Mexico or United States possessions.

To Canada One Dollar and Seventy-five Cents; to Other Countries Two Dollars and Fifty Cents a year. Single copies 10 cents.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill. Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

Copyrighted 1912 by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 22,500.

CONTENTS

Power Plant of a Modern Hostelry. Illustrated.....1165
Electric Passenger Elevators. By Wm. Kavanagh. Illustrated 1171
Steam Turbine Operation. By Thomas Sheehan.....1172
Lock Gates of the Panama Canal. By A. P. Connor. Illustrated 1173
Two and Two Are Four—Sometimes.....1175
A Changed Exhaust Valve. By W. Senge. Illustrated.....1175
Scientific Lubrication. By Thomas O. Organ.....1176
Practical Electrical Engineering. Illustrated.....1178
A. C. Generators. By H. P. Hill. Illustrated.....1180
Care and Operation of Commutators. By W. A. Dick.....1181
Steel Belts. By Francis G. Wickware. Illustrated.....1183
Special Slide Rule. By R. M. Fotheringham. Illustrated....1185
Heat Transmission Through Corrugated Iron. Illustrated..1186
Foreign Development in the Power Plant Field. By J. H. Blakey. Illustrated 1188
An Absorption Machine Trick. By Walter C. Edge.....1189
Letters Direct from the Plant: Trouble with Leblanc Pump. Testing Rod Packing; Engine Capacity. Heating System. Surface Condenser Installation. Area of Triangle. Gas Firing. Eccentric Rod Adjustment. Check Valve Problem. A Cracked Gage Glass. Illustrated.....1190
Successful Kinks from the Plant: Handy Devices Around the Plant. Wedge Bolts for Connecting Rods. Mould for Babbitting Crosshead Shoes. Concrete Acid Tank. Illustrated 1194
Correspondence of an Old Engineer and His Son.....1196
Increasing Capacity of Air Compressor. By C. R. McGahey. Illustrated 1197
Questions Answered and for Answer: Pounding in an Engine. Erecting a Boiler. Pump Trouble. Heating Problem. Criticism of Engine Card. Throw of Eccentric. Starting a Corliss Engine. Illustrated.....1198
Problems for Discussion: Exhaust Pipe to Pond. Well Water Problem. Packing for Grading Engine. Correspondence Instruction. Fluid for Dashpots. Charging a Small Battery. Burning Shavings. Running Pumps with Compressed Air. Illustrated.....1202
Editorial: Back to Coal. A Power Bureau.....1204
Synchronous Motors in Mine Work. Illustrated.....1206
Circulation Test of Robb-Brady Scotch Boiler. Illustrated..1207
Test of Cork Sheet Insulation.....1208
Golden-Anderson Valves. Illustrated.....1209
New Centrifugal Pumps. Illustrated.....1209
News Notes 1210
Book Review 1211
Catalog Notes 1212
Trade Notes 1214

BACK TO COAL

Coal, since its discovery, has been the chief power fuel, and in most sections of the world the only one. But certain locations have, for some years past, been able to enjoy the advantages of gas or fuel oil for steam generation and combustion engines. The natural gas supply has been nearly exhausted for some time, and, even with careful husbanding, the time is near when it cannot be used for any purpose where low cost and large volume are essential.

Now the Standard Oil Co. announces that fuel oil contracts are not to be renewed in many states. Reasons not given, but it is well understood that more gasoline is needed to meet the fast growing demand and the price is rising so that the more expensive treatment needed to secure the gasoline content from heavier oils will soon be profitable. Stationary plants must therefore prepare to use coal at all times in either boiler or producer, or else make such change as will permit of using distillate from the refineries in combustion engines. The demand for coal will be increased and prices are likely to rise so that lower grades and thinner veins will be profitable.

It would seem that we are at the point when the first step towards higher cost fuels is at hand, and that the Standard Oil Co., farther sighted than the country at large, is taking the only effective course to show the need of conserving our fuel resources.

A POWER BUREAU

In the Rainey Bill now before the House it is proposed to establish in the Department of Agriculture a bureau for farm power to investigate and report upon methods and machines for doing farm work, such as vehicles, plows, reapers, and stationary tools. No question but that the larger use of mechanical power on farms will be advantageous in relieving drudgery, lowering cost, increasing yield and releasing land to produce food for man rather than draft animals, but the question arises, "why a bureau of farm power and not one of factory power?"

Experiment stations in several states have done much work along the proposed line, but have been impartial in investigating and reporting on power machinery and apparatus for agriculture and manufacturing. This work is of the highest importance in enabling farmers and manufacturers to adopt the best methods and avoid mistakes, and in reducing unnecessary fuel consumption. It is quite as much to the interest of the manufacturer to have food yield increased and cost lowered as to that of the farmer; but it is also to the interest of the farmer to have the output of manufactured goods which he buys increased and the cost lowered. Any help that the departments can give to either will be of benefit to the whole country. The Bureau of Mines has done much important work in the investigation of fuels and their use; the Department of Agriculture has gathered much information about the use of the combustion engine on the farm. Data are needed as to cost of producing crops with mechanical and animal power, and the sizes of machines economically adapted to farms of various sizes. Also as to the type of prime movers best adapted to different size industrial plants.

In the interest of all, why not a Power Bureau which shall work jointly under Mines, Agriculture and Manufacturers to collect data, investigate methods and machines and report results of interest to any great line of industry or to all lines?

STEAM ENGINE AND STEAM TURBINE NUMBER OF PRACTICAL ENGINEER

RESUME OF WHAT READERS MAY EXPECT IN JANUARY 1st, 1913 ISSUE

THE ISSUE WILL BEGIN with the bottom and fundamental subject of foundations, how to proportion and arrange them, the materials and methods used, setting up and lining up the engines and the proper layout of piping systems.

The action of valves, the power developed and how to measure it; the effect of condensers on power and efficiency and the relative value of increasing initial pressure and lowering back pressure will be fully explained.

Engines will be classified according to the details of the valves and the methods of driving them. The first great class will be the single valve, the piston valve, the multiport, and the balanced valve, accompanied by descriptions of engines using such valves.

The second class will be those engines using 2 valves, either a main valve with a riding cutoff, or separate valves for steam and exhaust; and engines using such valves will be fully described in detail.

Four-valve engines will next be taken up and explained as to the advantages of this type and the details of the valves used in practice. This class will include only the reciprocating valves, or where reciprocating and Corliss valves are used in the same engine.

The next great division will be the Corliss valve with detaching mechanism, treated under 2 general classes—the single eccentric and the double eccentric—with full description of commercial engines.

The next class will be the 4-valve positive driven Corliss, which is becoming one of the most important types in the field. Full descriptions will be given of all the different engines of this type, showing the mechanism by which the valves are driven, and the styles of valves in use in these engines.

The final class will be miscellaneous and special valves, including poppet valves, rocking valves other than Corliss, and special arrangements such as the Lentz and the Uniflow types of engines.

Throughout this section, which is devoted to the classification of engines, care will be taken to illustrate all special points of each engine, while giving general, typical details of different engines to illustrate common features of design.

The next section of the issue will be devoted to compounding of engines, giving the reasons for compounding, and discussing the general principles on which proportioning of cylinders and determination of receiver pressures are based, so that the users may determine what is the best operating set of conditions for a given engine, or what proportions of engine will best suit a desired set of operating conditions.

The subject of governing will come in for careful consideration, showing the different methods used in governing engines, and the mechanism adopted for accomplishing these results. This will include the flyball governor, both with and without weights, and having both gravity and springs as the opposing force; also shaft governors of the centrifugal and inertia types, and the mechanisms used for shifting the eccentrics around or across the shaft.

The following section will discuss typical details of design, such as frames, bearings, flywheels, cranks, crossheads, etc., showing the different forms used and giving the advantages of each for different situations, illustrating these typical forms by reference to the description of commercial machinery.

Steam turbines will be treated at length, as befits their importance in the field at the present time. The different types will be classified, the different methods of staging for reducing pressure by degrees, the methods of governing employed, the forms of nozzles for different conditions.

Arrangements of nozzles and of blades on wheels and on diaphragms, the use of superheat and how much is wise, proper condenser pressure to give best economy for different operating conditions, the use of the bleeder and low pressure turbine for special cases, and finally a complete description of the details of commercial turbines as at present in use.

Power Apparatus in Shop and Market

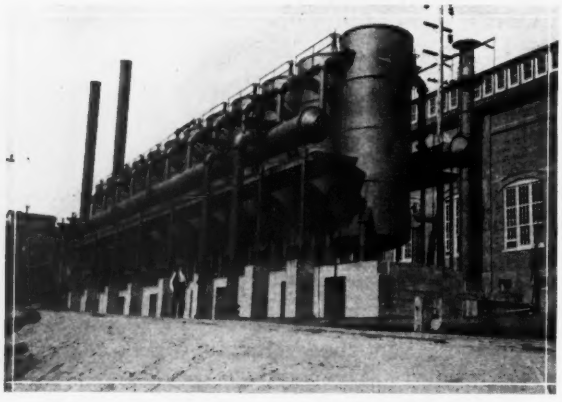
New Ideas In Making, Buying and Selling

SYNCHRONOUS MOTORS IN MINE WORK

Power Transmitted by Electricity and Distributed by Compressed Air

OF late much attention has been given to the institution of economics in the mining of copper ore, and one of the principal steps towards the reducing of the cost of copper per pound has been the gradual but continual displacement of steam plants by installations of electric power. Wherever possible, direct electrification has been the rule. In places where this has been feasible, compressed air, produced by electrically driven compressors, has often been used to advantage. The next step towards securing greater economy of operation has been to centralize the electrically driven compressors.

The various properties of the Amalgamated Copper Company in the Butte District of Montana probably have the largest output of copper in the world for the same extent of territory. For this reason and also because the district is comparatively limited in area, this company has led in the building of large electrically operated central compressor installations.



RECEIVER SYSTEM AT A CENTRAL COMPRESSOR PLANT

Particular advantages have accompanied the centralization of the air compressor stations. Where formerly each mine ran its own compressors, there are now 4 large compressor stations which have displaced most of the isolated compressors formerly used.

The plant of the Neversweat is the oldest. At this point there are installed 3 300-hp. and 1 800-hp. induction motors driving air compressors. The next plant to be built, that at the Leonard is equipped with 2 550-hp. and 2 660-hp. induction motors. The third plant, that at the Bell, has 4 600-hp. motors.

For the last plant, known as the Central Compressor Plant, it was decided to increase the size of the unit over anything attempted previously, to use direct connected drive, and to install synchronous motors. Accordingly, at this plant there are installed 3 1200-hp. engine-type synchronous motors, built on the shafts of the air compressors. A fourth 1200-hp. motor is on order and 2 more of the same size are to be ordered at a later date, making the ultimate capacity of the plant 7200 hp.

The economies of electrifications are apparent when it is considered that the cost of one horsepower a year generated in the Butte District by steam varies from $80 to $125, while for isolated electrical installations the cost a horsepower year was reduced to from $35 to $60. By centralizing these plants, further economies were effected, both on account of reduced maintenance and due to the fact that the load factor on these centralized plants was much better than the load factor on individual installations, thus saving a considerable investment in motors and compressors. The use of direct connected synchronous motors effects still furthered economies by permitting a better efficiency per unit to be obtained; by reducing the cost per horsepower installed; by eliminating the loss in rope transmission; by decreasing attendance charges, and by permitting the synchronous motors to be used to correct the power factor, in return for which the power company was willing to make a considerable reduction in the cost of power. In this new central compressor plant the cost a horsepower year will be in the neighborhood of $25.

Compressors were built by the Nordberg Manufacturing Co. They pump into a large receiver system, consisting of a considerable number of steel tanks; some of these are shown in the illustration. Constant pressure is maintained hydraulically, a huge water tank being located on a hill some distance above the receivers. By thus permitting the compressors to pump into a receiving system and causing the various machines in which the air is used to draw upon these receivers, the individual compressors operate continuously at full load and maximum efficiency, large variations in load being taken care of by starting or shutting down an entire compressor unit.

In starting the synchronous motors a novel method is used. The valve gear on the compressor is arranged with a link motion, somewhat similar in purpose to that used on a locomotive, but considerably different in design. By means of this link motion, the valve motion may be reversed and by introducing compressed air from the receiver system, the compressor may be actuated as an air engine. In this way a compressor may start its synchronous motor and bring it up to the proper speed for synchronizing it with the power supply line. A refinement has been added to the switchboard equipment furnished at this plant, by means of which the motor may be automatically connected to the supply line when it reaches the proper

speed, thus eliminating the necessity of synchronizing by hand. This refinement consists of an automatic synchronizer so arranged that it operates by means of solenoids the main switches between the bus bar and each individual motor. While this automatic feature is not always used it acts as an extra safeguard to render the station more reliable.

A still further safeguard is provided by having the motors designed so that if absolutely necessary they may be started by supplying current directly to the armature. The field is provided with a cage type winding, which, while ordinarily used to prevent hunting, permits the motors to act as induction motors at starting. This method of starting is used only in case of emergency, when no other means of starting are available. The feature has, however, the great advantage that the plant can still be started from a complete standstill even if there is no air in the storage system.

Considerable quantity of the compressed air from this central compressor plant is used to operate the large hoisting engines at the various shafts located in its immediate vicinity. The balance is used to operate the pneumatic drills used underground.

Hoisting engines now pneumatically operated, were formerly operated by steam. To adapt them for air operation, only a few changes were required. It has been figured that the economy in hoisting secured by the use of compressed air in the manner here described will reduce the cost of copper approximately one-half a cent per pound which, considering the tremendous output of the Butte mines, means an immense annual saving.

Calculations of the cost of hoisting by electricity direct, indicate that the economy of electric hoists would be even greater than that secured by the use of compressed air, but, on the other hand, the installation of electric hoists would have meant the entire discarding of the present equipment, the purchase of considerable equipment that would be of no service except in connection with hoisting, and further to obtain the advantages of a storage system, such as is afforded by the receivers at the central compressor plant, motor-generator sets with large flywheels and storage batteries would have been necessitated. For these reasons and certain other considerations, it was not considered feasible in this particular instance, to electrify the hoists themselves, although for most installations the direct electrification of the hoists will prove more economical than the use of electrically compressed air.

On account of the importance of the mining operations in Butte, the great expense of even temporary shut-downs, and particularly on account of the compressed air being so largely used for hoisting purposes, the reliability of the apparatus to be used was given the greatest consideration by the engineers of the mining company. For a long time there was considerable doubt as to whether synchronous motors of this size could be made as reliable as induction motors. It was thought that if there were any very large variations in load, or if unforeseen circumstances disturbed the normal condition of the electric power supply the motors might fall out of step. So when synchronous motors were finally decided upon, rigid guarantees regarding successful and continuous operation were required from the manufacturers, but the machines have more than lived up to their guarantees.

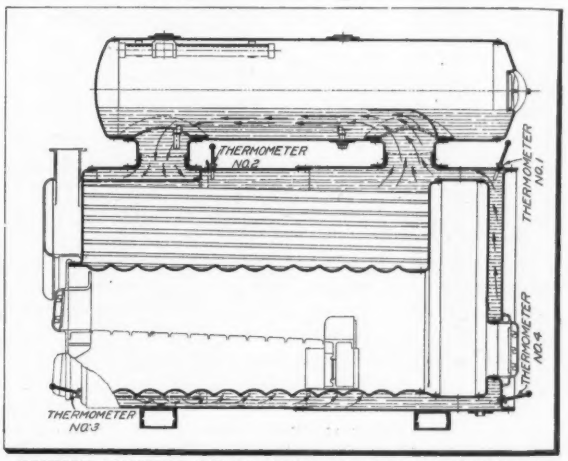
Since the early part of 1910, when the first synchronous motor was placed in operation, not a single failure of any kind has occured, and although the power supply during this time has often been unsteady, and despite the fact that there have been large variations in both voltage and load, none of the motors have ever fallen out of step nor has there been any disposition on their part to hunt. For this reason it has been recently decided to double the capacity of the original installation.

Three motors now installed and the one now on order are all rated at 1200 hp., 3-phase, 2400 v., 60 cycles. They have an overload capacity permitting continuous operation at 25 per cent overload and 50 per cent overload for one hour. Practically, therefore, they are 1500-hp. motors. On account of the slow speed required, due to their being direct connected to large compressors, they have 96 poles, giving a speed of 75 r.p.m. They were built by the Westinghouse Electric & Manufacturing Co. The dimensions are probably larger than any other synchronous motors ever built for this class of service.

The electrical energy used is generated on the Missouri River by the Great Falls Power Co., and transmitted approximately 100 miles under a pressure of 110,000 volts to the point at which these motors are installed.

CIRCULATION TEST OF ROBB-BRADY SCOTCH BOILER

INCREASED circulation, secured by changes from the standard form is obtained in the Robb-Brady Scotch boiler which is a modified form of the standard Scotch marine boiler. The heating surfaces are arranged as in the standard form and there are the same internal furnace flues, but there are 2 smaller shells, one above the other, in place of the large one and an annular



SECTION SHOWING CIRCULATION AND THE LOCATION OF THERMOMETERS

circulating passage is formed at the front end by the use of a plate beneath the front neck. This plate guides the cooler feed water around the shell discharging it beneath the furnaces at the front. The water is heated while passing around the furnace and among the tubes, and enters the steam drum by the rear neck.

The claims for positive circulation made by the builders were thoroughly tested a short time ago at the Sewerage Pumping Station, Framingham, Mass. The Robb-Brady boiler at this plant was equipped with thermometer oil wells so that the temperature could be noted at 4 points, as follows: At the top of the shell near the front end; at the top of the shell at the rear

just over the combustion chamber, at the front and rear close to the bottom.

With water in the boiler at about 80 deg. the fires were started and readings of all thermometers taken every 5 min. As was expected, the temperature of the water at the top of the shell increased steadily until the boiling point was reached. At the bottom, the temperature increased very slowly up to the time the upper thermometer indicated the boiling point. Then the lower thermometers showed a sudden rise; they jumped to within a few degrees of those at the top. From this time on all 4 kept within a few degrees until 100 lb. pressure was reached at which time practically no difference could be noted at the 4 points, showing conclusively that the circulation was positive and rigid. How

TEMPERATURE TEST

60 HR ROBB BRADY SCOTCH BOILER MARCH 31, 1912

FRAMINGHAM SEWERAGE PUMPING STATION, SO. FRAMINGHAM, MASS.

TIME P.M.	THERMOMETER NO. 1 ON TOP OF BOILER AT REAR END. FAHRENHEIT DEGREES	THERMOMETER NO. 2 ON TOP OF BOILER AT FRONT END. FAHRENHEIT DEGREES	THERMOMETER NO. 3 AT BOTTOM OF BOILER AT FRONT END. FAHRENHEIT DEGREES	THERMOMETER NO. 4 AT BOTTOM OF BOILER AT REAR END. FAHRENHEIT DEGREES
3:40	114	112	80	82
3:45	126	124	80	82
3:50	138	140	80	83
3:55	150	150	81	84
4:00	170	170	82	86
4:05	184	190	84	87
4:10	210	210	98	90
4:15	226	224	210	136
4:20	231	230	226	180
4:25	244	242	234	230
4:30	258	260	252	248
4:35	276	278	268	270
4:40	292	292	292	290
4:45	310	308	306	310
4:50	★ 328	330	328	328
4:55	330	330	328	330
5:00	327	328	327	327

★ SAFETY VALVE BLOWING OFF

well this design fulfills the purpose is shown in the accompanying table, which gives graphically the thermometer readings at 5-min. intervals. The test proved that troubles due to poor circulation in marine boilers have been eliminated, and that good circulation is easily obtained with the Robb-Brady device which forms an integral part of the boiler and is not an external apparatus. The boiler is built under patents held by the Robb Engineering Company, Ltd., of South Framingham, Mass., and Amherst, N. S., Canada.

TEST OF CORK SHEET INSULATION

RECENTLY, test was made by the Underwriters' Laboratories, under the direction of the National Board of Fire Underwriters, Chicago, of pure cork sheets, manufactured by the H. W. Johns-Manville Co., New York.

The main purpose was to discover the resistance of the material to destruction by fire under conditions fully as severe as could possibly be expected in actual service. For this purpose a section of 3-in. hard-baked hollow tile wall was built in a steel frame prepared for this purpose, about 10 ft. high by 8 ft. wide, and on this there were erected in Portland cement mortar, with joints broken, 2 courses J-M cork sheets, each 2 in. thick, and finished with ½ in. Portland cement, troweled smooth, the work being done in the same manner as the company erects such insulation in cold storage plants. The panel was 12 days old at the time the test was made.

The method of testing consisted of exposing the panel, constructed in the manner described, to the attack of a soft, rolling gas flame for one hour with temperatures rising to 2000 deg. F. The furnace was controlled so that the temperature rose uniformly throughout the test, the maximum temperature being reached at the 60 min. period.

At the starting of the test the temperature of the wall section or panel was about 62 deg. F., and at its close the thermometers imbedded in the cork registered an average of 72.5 deg. F., while those at the inner edge of the surface of the tile wall averaged about 3 deg. F. lower.

This is a remarkably efficient showing. It was impossible to tell by the touch at the close of the test on the back of the tile wall that there was any excess heat on the other side of it, and yet the gas flames had been directed upon the other side for an hour.

Directly following the fire treatment and while the surface of the panel was still in a highly heated condition, a stream of water was applied to the heated surface. It was applied for 5 min. through a ⅞-in. nozzle, set 20 ft. from the panel and at a pressure of 60 lb. per sq. in. measured at the base of the nozzle.

The result of the exposure to the gas flames for an hour, followed by the application of the hose stream for 5 min., was to calcine and destroy the outer coating of plaster, and to carbonize and partially destroy the outer layer of 2-in. cork sheets, but the transmission of heat through the carbonized cork layer had been so slow that the cement coating between the 2 courses of cork was practically uninjured, the under course of cork remaining intact.

The tile wall was in perfect condition. Consequently had this experience taken place in a cold storage building it would only be necessary to have cleaned away the light debris, dry the remaining wall and again erect a second course of 2-in. cork sheets, and plaster them with cement mortar to have the storage room in sound serviceable condition again, thus saving the majority of the insulation and, what is of even greater moment, the building walls.

In brief, the conclusions were that the material is suitable for cold storage insulating purposes; that the process of manufacture is such as to produce a uniform, satisfactory product; that the general practice of applying the material is such that with reasonable care and skill it will insure a good and satisfactory construction; that it is sufficiently strong to carry its own weight on walls and ceilings; that the two-course construction affords very considerable protection from fire to those portions of construction to which it is applied; that it will effectively resist the passage of flame; that it affords very considerable resistance to the transmission of heat; that it is not unduly susceptible to injury by unequal expansion when exposed to high temperatures; that the two-course insulation resists the impact and eroding effect of fire streams moderately well after being subjected to high temperatures, and that consequently the properties of the material and its method of construction recommend its use in refrigerating structures.

GOLDEN-ANDERSON VALVES

Combined Throttle and Automatic Engine Stop Valve for Electric and Hand Operation

REFERRING to the sectional view, interest at once centers in the positive manner of construction and operation. The steam pressure entering the valve at the port marked inlet on the top of the valve disk underneath the large piston and at the same time flows through the side port C on top or above the large piston D and through port G, which fills the space marked F underneath the piston D, hence it is thoroughly balanced. The by-pass arrangement is through the valve disk E and by raising the

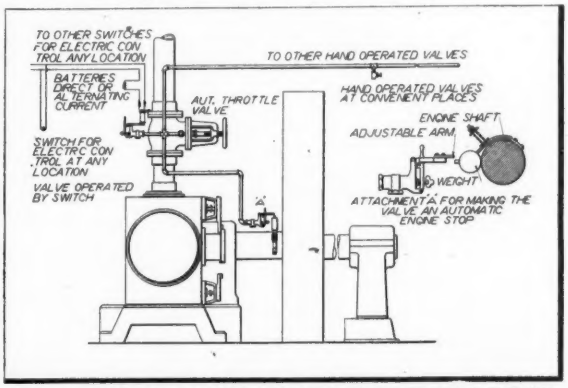

TO OTHER SWITCHES FOR ELECTRIC CONTROL ANY LOCATION
TO OTHER HAND OPERATED VALVES
BATTERIES DIRECT OR ALTERNATING CURRENT
AUT. THROTTLE VALVE
HAND OPERATED VALVES AT CONVENIENT PLACES
ENGINE SHAFT
ADJUSTABLE ARM
SWITCH FOR ELECTRIC CONTROL AT ANY LOCATION
WEIGHT
VALVE OPERATED BY SWITCH
ATTACHMENT A FOR MAKING THE VALVE AN AUTOMATIC ENGINE STOP

FIG. 2. HOW THE VALVE IS ATTACHED TO THE ENGINE

spindle steam is permitted to pass through to the engine and pipe connections for the purpose of warming up and equalizing the pressure before opening the main valve.

The electric solenoid attachment can be wired up to as many different points as desired. Should an accident occur, such as a break in machinery or injury to employees, simply pushing a button or throwing a

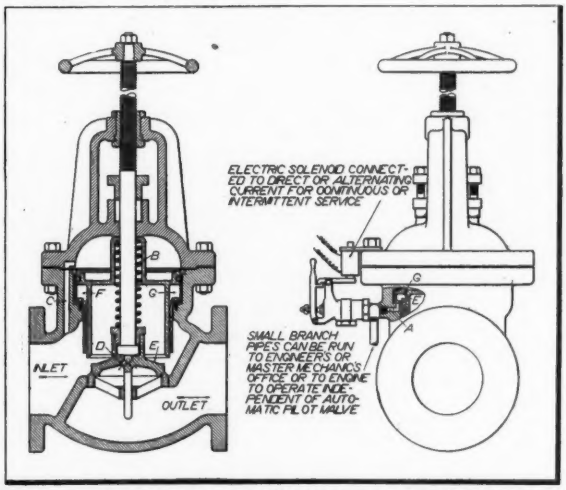

ELECTRIC SOLENOID CONNECTED TO DIRECT OR ALTERNATING CURRENT FOR CONTINUOUS OR INTERMITTENT SERVICE
SMALL BRANCH PIPES CAN BE RUN TO ENGINEERS OR MASTER MECHANICS OFFICE OR TO ENGINE TO OPERATE INDEPENDENT OF AUTOMATIC PILOT VALVE
INLET
OUTLET

FIG. 1. CROSS SECTION AND ELEVATION OF GOLDEN-ANDERSON VALVE

switch in contact would cause the solenoid to trip the latch on the pilot valve, exhausting the pressure from beneath the large piston D, forcing it to its seat, closing the valve, cutting off steam to the engine.

Should the automatic feature be desired, a connection with a strong and flexible spring with balance weight attached and an adjustor is made to trip the pilot valve as shown in the cut. Should the engine run away, the centrifugal force will cause the balance weight to trip the pilot valve, exhausting the pressure from the space F beneath the large piston. The full boiler pressure always being above the piston D, will force the same to its seat, cutting off steam to the engine, turbine, pump, air compressor, etc. As will be noted, small branch pipes can also be attached to operate by hand and close the valve independent of either or both the other attachments. In any of these operations, it will be appreciated that the large piston D is always thoroughly cushioned in opening and closing.

NEW ELECTRIC CENTRIFUGAL PUMP

AN automatically controlled centrifugal sump pump, for draining basements, handling domestic sewage, pumping out bilges, etc., where the liquid collects in a sump, has been developed by the Goulds Manufacturing Company, Seneca Falls, N. Y.

The outfit, as shown by Fig. 1, consists of a vertical electric motor direct connected to a Goulds single side suction pump. The pump is connected to a cast iron pit cover, by a rigid pipe column. This cover also acts as a support for the motor pedestals. The shaft

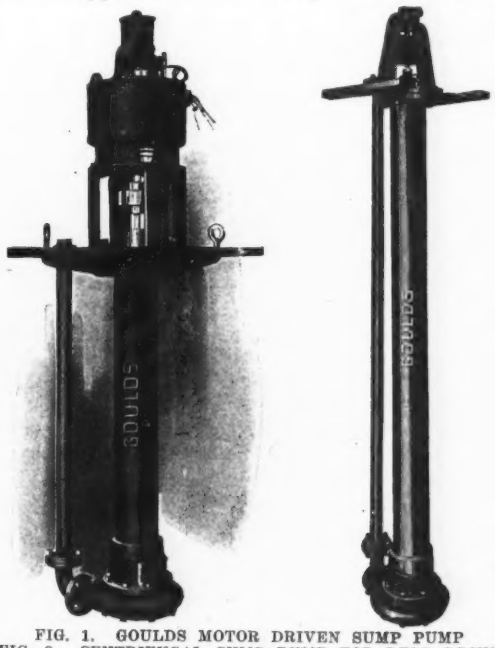


FIG. 1. GOULDS MOTOR DRIVEN SUMP PUMP
FIG. 2. CENTRIFUGAL SUMP PUMP FOR BELT DRIVE

is enclosed by the column which connects the pump to the cover and is therefore, protected from the liquid in the pit. A cover plate on the flange which connects the pump and supporting column permits inspection of the stuffing box.

The electric motor is controlled by a starting device, actuated by a float in the sump. When the liquid rises to a certain level and the float is lifted enough to close the switch the motor is started. It continues to operate until the sump is nearly empty, when the float drops back to the position where it opens the switch.

For service where electric current is not available, a similar pump has been developed, equipped with a pulley for belt drive by a gasoline engine or other power. This pump is shown in Fig. 2.

NEWS NOTES

GOVE S. TAYLOR has taken position with the Magnolia Metal Co. as its special representative in the Pittsburgh district and surrounding territory. Mr. Taylor was for years manager of the Peerless Rubber Mfg. Co., and is widely and favorably known to the mill supply and power house trade throughout the United States and Canada.

AT PITTSFIELD, MASS., work on the new addition to building No. 26 of the General Electric plant is progressing rapidly and the contract calls for the completetion of the new building by Jan. 1. When this addition is completed it will give the fan motor department 30 per cent more floor space and will employ 200 more hands.

THE NEW KISSELKAR factory at Center and Thirty-third streets, Milwaukee, Wis., formerly the Romadka Brothers trunk factory, is fast nearing completion and by the first of the year will house from 1000 to 1500 workmen and machinery capable of a yearly output of 10,000 cars. A portion of the machinery is already in place.

A LARGE GENERATING PLANT is to be constructed on Deer creek, 35 miles northeast of Chico, Cal., to furnish power and light to this section of the valley in opposition to the amalgamated companies now in the field. This is according to Dennis Murphy, Chico merchant, who owns the water rights along Deer creek. Surveys of the Deer creek water right have been completed.

THE WHITE PINE Lumber Co., Portola, Cal., has started to lay the foundation for a box factory one mile from town. The building is to be 485 ft. in length and 50 ft. wide. They will also build a commissary and boarding house. The buildings will be finished and ready for occupancy by July 1. The local manager for this company is E. Cox.

ON THE FIRST ANNIVERSARY of the destruction by the memorable cyclone of November 11, 1911, of their plant, the Estey Manufacturing Co., of Owosso, Mich., celebrated the completion of its fine new brick plant, by inviting the public to inspect it. The new plant is 3 stories high, over 300 ft. long, 80 ft. wide, and is one of the most modern in the county. The factory is built on the site of the former plant.

WILLIAM N. HOBART, President of the Triumph Electric Co., and Triumph Ice Machine Co., of Cincinnati, and a former president of the Chamber of Commerce, passed away at his home on Friday, Nov. 14. He had been indisposed since September, but his condition became serious only on the previous Wednesday. He was interested largely in many enterprises and gave freely time and resources to further public welfare.

ON NOV. 1, Harry W. Jarrow became general sales manager of the Diamond Power Specialty Co., Detroit, in accord with an extensive selling campaign now being entered into by this company.

Mr. Jarrow comes to Detroit from 7 years in the mechanical and sales department of The Cable Co., Chicago, where he became assistant manager of sales in the player department a year ago. Besides this broad selling experience, Mr. Jarrow brings to the technical side of his new work a mechanical engineering training gained at the University of Pennsylvania and at the Armour Institute of Technology of Chicago.

THE JINX DID IT. In newspaper offices, there is a cat or a goat or some other hoodoo on which the mistakes are blamed. There is no live hoodoo in Practical Engineer office, so it must be the Jinx that bewitches things. (Jinx sounds sort of mechanical as if it might have wheels and go with a crank and misfire occasionally). Well the Jinx evidently got that item in regard to W. E. Sanders. Here are the facts. Mr. Sanders was formerly Sales Manager of the Mechanical Rubber Co., of Cleveland, O., and later was with the Thermoid Rubber Co., of Trenton, N. J., and now has become Sales Engineer for C. J. Tagliabue Mfg. Co., of Brooklyn, N. Y. By comparing with the Nov. 15 issue you can see what the Jinx did. (Note to printers.—If you let the Jinx get this, we'll get yours.)

THE ANNUAL NATIONAL EXHIBITION of commercial motor vehicles will be held in Chicago from February 10 to 15, 1913, occupying the second week of the Thirteenth Annual National Automobile Show. The display will be larger and more diversified than ever, filling all of the floor space in the Coliseum Building, Coliseum Annex, and First Regiment Armory.

Sixty-five motor truck and delivery wagon companies have contracted for space, and there is a waiting list of belated applicants. If there should be as many of these as there were last winter between the first allotment in October and the opening of the show in February, the total number of complete vehicle exhibitors will be about 90. Manufacturers have reserved larger spaces this year than last winter and will display more models. Most of them have extended their lines by adding new models of different load capacity, while some companies that heretofore have confined their attention exclusively to gasoline vehicles will exhibit new electric models and others that have produced only electric vehicles will show them side by side with gasoline trucks that they have brought out.

In all there will be on exhibition about 210 different models of motor vehicles suited to every kind of industrial, commercial, municipal and federal purpose. So many of these are entirely new designs that they will embody the latest improvements in every detail whereby the efficiency, reliability, durability, accessibility and general ability of the power vehicle is increased.

There will also be displays of parts, equipment and supplies by nearly 200 accessory manufacturers.

The Chicago show is held under the auspices and support of the National Association of Automobile Manufacturers, organized in 1900 and having a membership of more than 100 of the most reputable motor car manufacturers of America. Each winter the show is the largest and most representative exhibition of its kind in the United States, open to all manufacturers on equal terms irrespective of membership in any organization. No other industry in the world supports so large an annual display or attracts so many spectators.

"THE PRINCIPLES OF HEATING," by William G. Snow. This is a thoroughly revised and greatly enlarged edition of a work that has proven its value by going through three large editions in a comparatively short time. In preparing the fourth edition the author has rearranged the work from beginning to end, so that it may now be used either as a text-book on applied theory in heating, or as a reference work to every modern system.

The price is $2.00. Despite the fact that considerable of the old material has been eliminated, there are now 54 more pages of matter and 22 additional tables.

BOOK REVIEW

COMPARATIVE FUEL VALUES of Gasoline and Denatured Alcohol for Internal-Combustion Engines is a bulletin giving the results of more than 2,000 tests, just issued by the United States Bureau of Mines.

R. M. Strong and Lauson Stone, the authors, say in their introduction: "When this investigation began, the extensive introduction, especially by foreign powers, of liquid fuels for small naval craft had awakened much interest. The quality of gasoline was, however, reported to vary materially in different countries and the quantity available was said to be rapidly decreasing, with the probability of a prohibitive increase in price. At the same time the claim was made that denatured alcohol, of fairly uniform quality, could be procured in all parts of the world, that unlimited quantities could be readily produced at a low cost, and that this fuel could be used much more efficiently than gasoline in internal-combustion engines. Such statements naturally led to a widespread belief that the time was near at hand when denatured alcohol would entirely displace gasoline as engine fuel.

"The low heating value of completely denatured alcohol averages 10,500 B.t.u. a pound, or 71,900 a gallon. The low heating value of gasoline having a specific gravity of 0.71 to 0.73 averages 19,200 B.t.u. a pound, or 115,800 B.t.u. a gallon. The low heating value of 1 lb. of alcohol is approximately 0.6 the low heating value of 1 lb. of gasoline.

"One pound of gasoline requires approximately twice the weight of air for complete combustion that is required by 1 lb. of alcohol, and the heating value of 1 cu. ft. of an explosive mixture of alcohol vapor and air having theoretically just sufficient air for complete combustion is approximately equal to that of 1 cu. ft. of a similar explosive mixture of gasoline vapor and air—about 80 B.t.u. a cubic foot.

"Explosive mixtures of alcohol vapor and air in an engine cylinder can be compressed to much higher pressures, without pre-igniting, than explosive mixtures of gasoline vapor and air. The maximum compression that can be used in an engine without causing pre-ignition depends on the quality of the explosive mixture, the design of the engine, and the speed at which it is operated.

"For 10 to 15 hp. 4-cycle stationary engines of the usual type a pressure of about 70 lb. a sq. in. above atmospheric pressure was found to be the maximum that could be used for gasoline mixtures, and about 180 lb. the maximum that could be used for alcohol mixtures, without causing pre-ignition. The maximum compression that could be used without causing pre-ignition was in each case found to be the most advantageous with regard to fuel economy.

"When the degree of compression in each engine is that best suited to the economical use of the fuel designated, some types of gasoline engines are better adapted for that fuel than for alcohol engines, and vice versa. But, in general, the alcohol engine is or can be so designed and constructed as to be equal to the gasoline engine in adaptability to service.

"A gasoline engine having a compression pressure of 70 lb. but otherwise as well suited to the economical use of denatured alcohol as gasoline, will, when using alcohol, have an available horsepower about 10 per cent greater than when using gasoline."

Copies of the bulletin may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

MATERIALS AND CONSTRUCTION, by James A. Pratt, 196 pages, 5 by 7 in., price 90c. The purpose of this book is to present such studies in the elementary laws of construction which will give the student understanding of the most difficult formulas and ability to apply such to everyday practice. The problems hold very closely to the practical; all those presented for design work are such as have come to the author's notice one way or another during a number of years' experience in engineering work.

STRENGTH OF MATERIALS, by Mansfield Merriman, 170 pages. In this book an attempt is made to give a presentation of the subject of the strength of materials, beams, columns and shafts, which may be understood by those not acquainted with calculus. The degree of mathematical preparation required is merely that now given in high schools and includes only arithmetic, algebra, geometry and such a course of mechanics as is found in elementary works on physics.

A TEXT BOOK OF PHYSICS, edited by A. W. Duff, third edition revised, with 595 illustrations, 686 pages, 5½ by 7½ in. The preparation of a work of this grade by the collaboration of several writers is a somewhat novel undertaking and some explanation of its genesis will not be out of place. It represents the attempt of several experienced teachers of college physics to compile a text book that would be more satisfactory to all of them than any existing one. The writers have endeavored to present their subject simply and directly, avoiding on the one hand explanations obvious to any student of fair capacity and on the other hand subtle distinctions and discussions leading to more advanced courses.

MACHINE DESIGN; Hoists, Derrick, Cranes, by H. D. Hess, 168 pages, bound in cloth, 6 by 9, price $5.00 net. This book is intended to aid the work of machine design in technical schools and colleges where a general field of machine design is covered. The problems are directed with this in view rather than that of appealing to the specialist in crane design.

THE MODERN GASOLINE AUTOMOBILE, by Victor W. Page, 700 pages, 6 by 9; 500 illustrations; cloth binding; 1912. Price $2.50.

This work treats particularly of details of construction of modern cars, and directions for operation, maintenance and repair. It is written by a man who is master of his subject and has the ability to put what he knows before his readers so that they can understand and apply the facts given to the actual case in hand.

Any good mechanician can get the special knowledge needed for caring for modern cars and repairing them, and any owner or driver can get the hints necessary to reduce running cost and increase mileage from tires and fuel.

The book treats each part in detail; the engine and its operation, details of different makes; methods of carburetion and sectional views of commercial apparatus; ignition by spark coils and magnetos; lubrication and cooling systems; clutches and transmission gears of planetary and shifting types; the chassis and its parts; wheels, rims and tires; equipment and accessories, such as starters, lighting systems, shock absorbers; operating advice and hints; locating troubles; keeping up the car.

The cuts are big, clear reproductions from actual designs. The man who wishes to drive or care for a car intelligently can be sure of satisfaction in reading this book.

CATALOG NOTES

A BOOKLET ENTITLED WHY? on turbine boiler feed pumps, can be obtained of the Alberger Pump and Condenser Co., 140 Cedar St., New York.

"DIAMOND N" Pipe and Boiler Coverings are described and illustrated, with price lists, in the catalog of the Norristown Magnesia and Asbestos Co., Norristown, Pa.

PEERLESS AIR COMPRESSORS are illustrated, with descriptive tables, in Catalog B of the American Compressor & Pump Co., of Baltimore. Several tables of useful information concerning air are also given.

JOSEPH F. SCHILLER'S Balanced, Seatless, Automatic Blow-off Valve is described and illustrated in a booklet sent out by Joseph F. Schiller, 316 S. Lawrence St., Philadelphia.

THE TRAIL OF A PIONEER is the title of a handsome publication received from the American Engineering Co., Philadelphia. It discusses the use of Taylor stokers in 14 representative plants, from Boston to Milwaukee, and is a limited edition designed for engineers interested in this particular subject.

CATALOG No. 22, issued by the Monash-Younker Co., of New York and Chicago, is entitled Monash Steam Heating Specialties. The specialties include a noiseless radifier valve, of which a clear description and diagram are given. An accompanying leaflet explains the Monash Modulating Method of Steam Heating.

PLATT CENTRIFUGAL PUMPS are discussed as applied to irrigation, drainage, circulating water for condensers, dock pumping, waterworks pumps, fire pumps, and other fields of application. Instructions are furnished for erecting and starting them, and several pages consist of practical information of a more general nature. The pumps are manufactured by The Platt Iron Works Co., Dayton, O., and are described and illustrated in Bulletin No. 627-A.

THE GENERAL ELECTRIC COMPANY has just issued Bulletin No. 4925 describing its Combined Unit Mercury Arc Rectifier Outfit. This outfit consists of the constant current transformer, direct current reactance, tube tank and exciting transformer mounted on a common base. This arrangement makes the rectifier outfit, with the exception of the switchboard panel, complete in itself and forms a neat and compact outfit, adding much to the appearance of the station. The standard outfits are made in 25, 50 and 75-light sizes, for 25 and 60 cycles, 2200 volt primaries, and 4 and 6.6 ampere secondaries.

"THE COKING OF COAL at Low Temperatures with a Preliminary Study of the Byproducts," by S. W. Parr and H. L. Olin, has just been issued as Bulletin No. 60, of the Engineering Experiment Station of the University of Illinois. This bulletin reports the results of experiments on various types of Illinois coal with reference to the principles which govern their use in the production of coke. The temperatures used did not exceed approximately 750 deg. F. Reference is also made to the byproducts obtained at the temperatures employed.

Copies of Bulletin No. 60 may be obtained upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

THE BUREAU OF MINES announces the following publications for free distribution: Bulletin 43, on comparative fuel values of gasoline and denatured alcohol in internal-combustion engines, by R. M. Strong and Lauson Stone; 1912; 243 pp.; 3 pls. Bulletin 46, an investigation of explosion-proof motors, by H. H. Clark; 1912; 44 pp.; 6 pls. Technical Paper 25, on methods for the determination of water in petroleum and its products, by I. C. Allen and W. A. Jacobs; 1912; 13 pp. Technical Paper 28, on ignition of gas by standard incandescent lamps, by H. H. Clark; 1912; 4 pp.

More than one copy of the same bulletin cannot be given to one person. Requests for all papers cannot be granted without satisfactory reason. In asking for publications please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

IN A 120-PAGE BOOK entitled "DeLaval Steam Turbines, Multistage Type," the DeLaval Steam Turbine Co., of Trenton, New Jersey, has presented much more than an ordinary trade catalog. A third or more of this publication is devoted to a discussion of the "speed-compromise" problem, that is, find the best means of reconciling the high speed natural to steam turbines with the low or moderate speeds of driven machinery, and the relative advantages of the several fundamental types of turbines, as affecting this and other matters. The remainder of the book is occupied by a detailed description of the design and construction of the DeLaval multi-stage or multicellular turbine, which is built in capacities of 500 hp. and up, and of the DeLaval speed reduction gear, by means of which this turbine is applied to driving standard-speed direct-current generators, centrifugal pumps and blowers, and for rope and belt drive.

The book also contains a chart accompanied by a "steam scale" by means of which the energy available from the expansion of steam between given limits can be read off directly as heat units, velocity of the steam in feet per second, duty of foot pounds per thousand pounds of steam, and pounds of steam consumed per horsepower hour.

Copies may be obtained upon request to the De Laval Steam Turbine Co., Trenton, N. J.

ALLIS-CHALMERS CO., of Milwaukee, has issued the following bulletins: Nos. 1620, 1626, 1629 and 1630, on hydraulic turbines; No. 1615, on the Sioux Falls Light & Power Co.; No. 1617, on the Sewall's Falls Plant of the Concord Electric Co.; No. 1623, on the Priests Rapids power plant of the Hanford Irrigation and Power Co., Hanford, Washington; No. 1625, on the hydro-electric development of the Great Northern Power Co.

CATALOG No. 8, from the Alberger Condenser Co., 95 Liberty St., New York illustrates its high vacuum apparatus. A vacuum pump is compared to an air compressor, and the advantage of omitting the use of water in the interior of the vacuum cylinder is indicated, also the operation of the suction valve in the cylinder. In addition to the various types and views of dry vacuum pumps, some of the chief topics are barometric condensers, vacuum pans, cooling towers, centrifugal pumps and Wainwright Evenflow heaters.

Bulletin No. 3, from the same company, is entitled "Wainwright Apparatus from the Practical View Point," and Catalog No. 11 describes and illustrates Wainwright expansion joints.

ERIE CITY VERTICAL Water-Tube Boilers are described in a handsome booklet issued by the Erie City Iron Works, of Erie, Pa. The steel casing shown is a novelty in boiler settings.

"BOTH STAND on a Firm Foundation" is the title of a pamphlet issued by the McCord Mfg. Co., of Detroit, Mich., describing the McCord Force Feed Lubricators and the McKim Gaskets.

FROM THE WISCONSIN ENGINE CO., of Corliss, Wis., comes a bulletin describing the Wisconsin Crude Oil Gas Producer, designed to work upon the cheapest grade of crude, distillate or fuel oil, producing gas of 140 B.t.u. value.

PUMP SLIPPAGE, its cause and prevention, are treated in an attractive catalog issued by the Hill Pump Valve Co., of Chicago, to explain the advantages of its metal-back valve. Tables showing the cause of slippage are embodied in this catalog.

CATALOG NO. 15 of the A. F. Daum Co. ,of Pittsburgh, describes the Daum Refillable Cartridge Fuse Shells for electric light and power circuits. These fuses are made with ferrule or clip contacts, and the fuse element can be readily replaced after a blow-out.

THE POWER & MINING MACHINERY CO., of Milwaukee, Wis., has recently issued a catalog of over 100 pages, translated into Spanish for circulation in the Spanish speaking countries and islands. It is in every way a handsome book and shows the progressiveness of the company in campaigning for export business.

FROM THE Williams Patent Crusher & Pulverizer Co., of St. Louis, Mo., comes a testimonial catalog which relates the experience of users of the crushing machinery manufactured by this company. 22 pages of this catalog, which altogether has some 200 pages, is devoted to experience with coal crushing machinery.

FROM THE C. E. SQUIRES CO., Cleveland, O., we have received a neat little circular describing the Squires improved steam trap.

RELIANCE GAUGE COLUMN CO. Cleveland, Ohio, have sent us circulars describing the following Reliance specialties: Steam trap, safety water columns, and the "No-Noys" steam trap.

THE GENERAL ELECTRIC COMPANY has recently issued Bulletin No. 4975, which is a revision of its former bulletin, No. 4613, devoted to the Synchronism Indicator.

CHAIN BELT, the attractive little house organ issued by the Chain Belt Co., of Milwaukee, for September, has reached us. It contains some very interesting views of the work on the new Woolworth building now nearing completion in New York City.

FROM DETROIT LUBRICATOR CO., Detroit, Mich., we have received an attractive catalog No. 35, 1912 issue, describing and illustrating "Genuine Detroit" specialties. It is a book of 230 pages with attractive board covers and goes exhaustively into the description of this company's product.

IN A NEW 50-page catalog just issued by the Pulsometer Steam Pump Co., of New York City, the entire field of operation and the different engineering features of the Pulsometer are fully discussed.

The catalog gives figures and curves showing the steam consumption and the cost of operating a Pulsometer under different conditions and shows how it compares with other types of pumps.

THE GENERAL ELECTRIC COMPANY has just issued Bulletin No. A4001, which describes oil switches manufactured by that Company, which are intended primarily for use in small and isolated alternating current plants of voltages not greater than 3300. The bulletin contains connection and dimension diagrams, and also useful formulas for use in selecting oil switches.

AN EVERYDAY STORY, sent out by the International Harvester Co., is of intensely human interest, and teaches its lesson unobtrusively, but clearly.

BULLETIN No. 4977, just issued by the General Electric Company, describes that company's control apparatus—known as Type MK, which is designed for use where single car operation predominates, and where a uniform acceleration is not of such importance as extreme simplicity. This bulletin supersedes, in part, Bulletin No. 4761.

BULLETIN A4002, just issued by the General Electric Company, describes its Polyphase Maximum Watt Demand Indicator, Type W. The instrument is suitable for recording the maximum load of alternating current circuits irrespective of power-factor and voltage fluctuations. This supersedes the Company's previous bulletin on this subject.

THE NEW TYPE "BCR-43" Jackhammer is described and illustrated in a 12-page 6 by 9 bulletin, form No. 4021, just issued by the Ingersoll-Rand Co., 11 Broadway, New York City, New York. The machine is a new series of hand hammer drill designed to operate with either steam or air—for drilling down holes of average size and depth. It is automatically rotated, and equipped with the Butterfly valve, a simple piece of steel oscillating on a central trunnion, actuated by the mere unbalancing of pressure on each wing alternately, and requiring a negligible amount of power to operate. The drill has a cylinder 2¼ in. in diameter, 2-in. stroke, uses ⅞-in. hollow hexagon steel and weighs 40 lb. Catalog shows several views of drill in operation and lists sizes and prices of the hollow steels.

LAGONDA STRAINERS is the title of an attractive catalog recently issued by the Lagonda Mfg. Co., of Springfield, Ohio. The catalog first points out why a strainer is necessary and how much power is lost in plants, due to decreasing the vacuum by restricting the flow of condenser circulating water. The various sizes and types of strainers are illustrated. The points of superiority of this strainer are also taken up and photographs included showing how these strainers may be buried under the floors of boiler rooms with only the hand wheel projecting above the surface, thus preserving the available floor space and at the same time the strainer can be readily cleaned. Copies of this catalog may be had by addressing the Lagonda Co., at the above address.

McCORD LUBRICATORS are of the force feed type, and are fitted for all kinds of reciprocating machinery. The book telling about them is artistic and informing, and demonstrates why force feed lubricators pay, as well as showing how McCord lubricators are made and how they work. It also tells why McKim gaskets make tight and lasting joints.

SPECIAL CATALOGS of the Schaeffer & Budenberg Mfg. Co., of Brooklyn, on Columbia recording thermometers, give complete information in regard to the details of construction and the method of operating these thermometers, also the different graduations of recording charts which may be secured.

IN ITS BULLETIN No. 59 the Industrial Instrument Co., of Foxboro, Mass., describes the recording liquid level gages of its manufacture. It shows interior views, giving details of the mechanism by which the pressure is recorded, and the clock work movement which turns the dial. It also shows full sized charts as taken from the instrument.

FRANKLIN BOILER WORKS CO., of Troy, N. Y., has lately issued a catalog on the Franklin Water-Tube Boiler. Besides the descriptive matter and many illustrations, "pointers on boilers" are given, and also a list of plants in which Franklin boilers are installed.

THE ORGAN FEED WATER HEATER and Purifier is described and illustrated in a 15-page, 4 by 9-in. bulletin, issued by The Exeter Machine Works, Pittston, Pa. The bulletin contains a table showing the waste of fuel caused by scale resulting from impure feed water, and explains how the Organ heater averts such loss.

PUBLICITY ENGINEERING is the title of a folder sent by Walter B. Snow, 170 Summer St., Boston, giving an interesting exposition of a new type of specialist. The organization developed by the author is of particular interest to engineers or experts who object to personal advertising on ethical grounds or find it ineffective.

A CRITICAL STUDY and Comparison of Thermostatic versus Float Valves, by Spencer Curtis, has been sent out in pamphlet form by the Monash-Younker Co., of New York and Chicago. The article describes the installation and function of the valves, and compares the thermostatic and float types as to construction, operation, advantages and disadvantages.

THE HILLS-McCANNA CO., of Chicago, has sent us a booklet describing its force-feed lubricating pumps, high pressure gage cocks, low-water alarms, and swing joints for oil or grease.

THE MECHANICS' DIRECT READING Reference Scale is described in a circular issued by The Metals Specialty Co., West Pittsburgh, Pa. Diagrams show both sides of the scale. A list of data that can be obtained from the scale, and directions and suggestions for use are given.

BULLETIN NO. 4880, recently issued by the General Electric Company, describes a Signal Volt-Ammeter, known as the Type S-2. The instrument is used for testing direct current railway signal apparatus. The standard instruments are arranged for six capacities or combinations, so that three voltage ranges and three current ranges can be obtained.

TRADE NOTES

D. H. BURNHAM & CO., through its board of consulting engineers, has adopted the Monash Noiseless system of vacuum heating for The Continental & Commercial National Bank Building, of Chicago, which covers an entire city block, the largest building of its type under one roof in the world.

SCHADE VALVE MANUFACTURING CO. announces the establishing of agencies for the Schade controlling and regulating valves, as follows: Mr. W. N. Clifford, 104 High St., Boston, Mass.; O. C. Goeriz & Co., Postal Telegraph Bldg., San Francisco, Cal.

THE MESTA MACHINE CO. has received an order from the Alpha Portland Cement Co. for its plant at Cementon, N. Y., for 3 gas engines direct connected to 600-hp. alternating current generators. These engines are to operate on producer gas and are to furnish the power to their new extension at the Alpha plant. This will practically double the capacity of their present plant.

THE AMERICAN ENGINE CO., of Bound Brook, N. J., manufacturers of automatic high speed engines and American ball angle compound and American variable speed paper mill engines, states that it has recently received an order for a 250-hp. variable speed engine from the St. Lawrence Pump & Paper Co., of Toronto. It is also about to ship a 500-hp. American 4-Cylinder variable speed engine to the DeGrasse Paper Co., of Pyrites, N. Y., which is the second engine of this size sold to that mill. The American Engine Co. reports a constantly increasing business in the paper field.

THE VILTER MFG. CO., with offices at 972 Clinton St., Milwaukee, Wis., report the following among recent sales: Kroeschell Bros. Ice Machine Co., Chicago, Ill., 2 18 by 36 Corliss engines; Lincoln Packing Co., Lincoln, Neb., 25-ton refrigerating machine with 10 by 30 direct connected Corliss engine; Fairmont Creamery Co., Omaha, Neb., 91-ton refrigerating machine with 16 and 32 by 36 compound condensing Corliss engine; La Crosse Rubber Mills Co., La Crosse, Wis., 22 by 48 Corliss engine for belted service; Burson Knitting Co., Rockford, Ill., 24 by 42 Corliss engine for direct connection to electric generator; Swift & Co., Packers, Chicago, Ill., 23-ton refrigerating plant; Tilden Produce Co., St. Paul, Minn., 65-ton refrigerating machine with 16 by 36 Corliss engine; National Capital Brewing Co., Washington, D. C., 270-ton refrigerating machine and 22 and 42 by 34 compound Corliss engine; Cerveceria Moctezuma, Orizaba, Mex. Brewers, 3850 lb. can ice-making plant; The N. K. Fairbanks Co., Ltd., Montreal, Can., 42-ton refrigerating plant with 16 by 36 Corliss engine; Frontenac Breweries, Montreal Can., 250-ton refrigerating plant with 2 22 by 42 Corliss engines.

AMONG RECENT SALES of the York Manufacturing Co. the following are noted:

Wilmington Ice & Storage Co., Wilmington, N. C., 1 35-ton belt-driven refrigerating compression side, and 1 10-ton raw water can ice plant; Locust Farms Co., New York, N. Y., 1 30-ton horizontal double-acting belt-driven refrigerating compression side and refrigerating plant; United States House Office Building, Washington, D. C., 1 17-ton refrigerating compression side, and drinking water cooling system; United States Senate Office Building, Washington, D. C., 1 11-ton refrigerating compression side and drinking water cooling system; Johnson & Eady, Nassau, N. P., Bahamas Island, I 4-ton refrigerating belt-driven compression side and refrigerating plant; Palatina Brewery, Havana, Cuba, 4 single-acting York vertical ammonia compressors, 24 by 36, to replace ammonia compressors of another make and miscellaneous material; 2 75-ton vertical ammonia accumulators and 1 150-ton water storage tank; Swift & Co., Augusta Ga., 20-ton refrigerating horizontal double-acting belt-driven compression side and direct expansion refrigerating plant; Massachusetts Agricultural College, Amherst, Mass., 1 11-ton refrigerating belt-driven compression side, and 1 2-ton ice-making and distilling system, also brine-refrigerating system; Isaac Fass, Portsmouth, Va., 1 6-ton motor-driven refrigerating compression side and refrigerating plant; Carnegie Steel Co., Isabella Furnaces, Sharpsburg, Pa., 3 170-ton each, shell and tube brine coolers, "1912" type; New Orleans Cold Storage & Warehouse Co., New Orleans, La., 1 75-ton shell and tube brine cooler, "1912" style; Pacific Coast Provision Co., Los Angeles, Cal., 1 30-ton shell and tube brine cooler, "1912" style.

Sparks From The Advertising Pages

"Have you thought what Advertising means to the life of America? Do you understand that it is a guarantee of quality, and the agent of economy? Do you realize that if you are to succeed in any business or any profession, ADVERTISING WILL HELP YOU? Advertising is the LANGUAGE of business. It is the bright light by which commerce and industry find their way throughout the nation."

Thus did Arthur Brisbane, noted as perhaps America's most trenchant editorialist, summarize his message to the advertising men who gathered in Chicago upon the day and evening of November 16th to celebrate the laying of the corner stone for Chicago's new Temple of Publicity—a building devoted exclusively to the science and literature of advertising.

"Advertising," he says, "as the word indicates, is giving information.

"Literally translated, the word means 'to turn to,' from the Latin of ad—to—and verto—turn.

"The advertisement turns the public to the thing wanted. Advertising, the voice of commerce, tells the work that the thinkers, fighters and inventors of industry are doing.

"Especially important is the fact that plenty of advertising almost invariably means AN EXCELLENT AND HONEST PRODUCT.

"If you read that a man had invested a million dollars in a factory of brick, stone and iron, you would not need to be told that he would refrain from setting fire to that factory —especially if it were not insured.

"There are many business men that have put not one million, but five millions and ten millions, into an advertising reputation.

"They have put their millions into words and have created by them a reputation as solid as any brick or any iron. That reputation IS THEIR FORTUNE. That reputation is their life work. It is not insured, it cannot be insured.

"For the man who has put his millions into advertising, to lower the quality of his goods, to deceive the public, would be like setting fire to his millions without any insurance.

"The man who advertises gives hostages to the public and proves that it is his intention to succeed by giving value by living up to that which he has promised.

"Advertising has become the agent of economy.

"You have a merchant who does not advertise. He pays a clerk two dollars a day. And the clerk sells ten dollars' worth of goods.

"Naturally, that merchant must first pay the clerk his two dollars out of the ten dollars that you pay for the goods. That means twenty per cent profit, to start with, for the clerk alone.

"And then the store, which represents high rent, must take its part of your purchase money for rent, for heat, for taxes, insurance.

"And the proprietor must take his part.

"Where the man who does not advertise pays two dollars to the clerk and two dollars for rent and a dollar for insurance and delivery, and sells ten dollars' worth of goods, HE MUST TAKE FIVE DOLLARS FOR EXPENSES AND AT LEAST THREE DOLLARS FOR HIMSELF—AND YOU GET TWO DOLLARS' WORTH OF GOODS.

"A man with the same clerk and the same store, ADVERTISING, can sell one hundred dollars' worth of goods, so that out of one hundred dollars he can pay the clerk and the rent and the taxes and the overhead, and take the profit that he wants—and the whole thing amounts to less than one-tenth of the amount taken in.

"Nothing is more foolish than the fast-disappearing belief of the ignorant that when they buy goods 'they pay for the advertising.' They do nothing of the kind. The advertising pays for part of the goods and makes it possible to deliver the goods cheaper."

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—BY ENERGETIC AND PROGRESSIVE young man of 24 as assistant in medium size modern steam-electric plant. 3 years' experience with large Corliss engines. I. C. S. graduate and Chicago City License. Address Box 263, care of Practical Engineer, Chicago, Ill. 12-1-1

POSITION WANTED—MANAGERIAL position, with Gas Company. Can handle all ends. Mechanical and Clerical. Results guaranteed. Good references. Address Box 259, Practical Engineer, Chicago, Ill. 12-1-1

POSITION WANTED—AS ENGINEER or machinist anywhere in the south where climate is above freezing point. Can give best of references. Address Isaac B. Fairbanks. St. Louis, Mich. 12-1-1

POSITION WANTED—ENGINEER, technical graduate, 4 years' experience with steam, gas, oil engines and electrical machinery. Can get results, strictly sober. Address Box 260, Practical Engineer, Chicago, Ill. 12-1-1

WANTED POSITION—AS CHIEF ENGINEER by man with over 15 years' experience as Chief of large Refrigerating and electrical plant. Thoroughly competent to handle plant and men. Strictly sober. Best References and License. Address Box 261, care of Practical Engineer, Chicago, Ill. 12-1-1

POSITION WANTED—CHIEF ENGINEER wishing change, 20 years' experience with Corliss and automatic engines, direct and alternating current machinery. At present in charge of lighting, heating, refrigerating, and storage battery plant. Age, 39. Address Box 262, care of Practical Engineer, Chicago, Ill. 12-1-1

POSITION WANTED—By young married man as millwright. Not afraid of work. Strictly sober and steady. Have had experience wiring lights and motors. Will go anywhere, Northern States Preferred. Address V. G. Lomprey, 1714 Jenkins St., Menominee, Mich. 12-1-1

Wanted

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once. tf

Help Wanted

HELP WANTED—ENGINEER in each locality, by a little use of his knowledge, can secure free subscription to engineering magazines, free tools, etc., as premiums. We also want agents. This interests you? "All right, write right now." Baker Valve Co., 1855 E. 28th St., Minneapolis, Minn. 12-1-1

WANTED—SALESMEN TO HANDLE as side line the best lubricating grease ever put on the market. Liberal commission. Address Box 264, care of Practical Engineer, Chicago, Ill. 12-1-1

WANTED—WE WANT AN ENGINEER in every town and city in the U. S. to give us a little assistance, for which we pay liberally in cash. For particulars write to Box 599, Rochester, N. Y. 12-1-1

WANTED—ANY INTERESTED engineer or superintendent to send for our new illustrated pamphlet on Betson one-piece boiler furnace linings. See our advertisement page 107. Betson Plastic Fire Brick Co., 105 E. Dom. St., Rome, N. Y. 12-12

For Sale

FOR SALE—THE WHOLE OUTFIT of Electric Welding Co.'s motors, dynamos, drill, forge boiler, engine lathe, U. S. patent right; at once. 127 Hursan Street, Hoboken, N. J. 12-1-1

FOR SALE—New 30 H. P. Ball Automatic Horizontal engine. Lucas & Son, Bridgeport, Conn. 9-15-6

Patents and Patent Attorneys

FIND OUT FOR YOURSELF what to invent and how to procure and sell a patent for the same. My book, "Inventor's Universal Educator," covers the matter from A to Z. 140 pages, elegantly bound. Also contains 600 mechanical movements and 50 perpetual motions. Price, $1.00, postage free. Money returned if not more than satisfactory. F. G. Dieterich, 618 Ouray Bldg., Washington, D. C. 12-1-1

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson & Son, Patent Solicitors, 710 G. St., Washington, D. C. 11-1-2

WE SELL PATENTS. Established ten years. To buy or having one to sell write Charles A. Scott Co., 1098 Granite Bldg., Rochester, N. Y. 8-1-6 e.o.i.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owen Bldg., Washington, D. C. tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf. e.o.i.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request, 186 McGill Building, Washington, D. C. tf

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee will be mailed every subscriber sending in one new subscription to Practical Engineer. Gilt edges, bound in leather. tf

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf